COMPLIMENTARY

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EXPERIMENTAL HORTICULTURE STATIONS

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Experimental Husbandry Farms and Experimental Horticulture Stations

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Introduction

This is the eighth Progress Report on experimental work at the N.A.A.S. Experimental Husbandry Farms and Horticulture Stations.

The Report does not attempt to review the whole field of investigations in progress in any one year but presents a selection of topics of particular interest, either because they are new to the experimental programme or because they have reached a stage where conclusions of practical importance can be reported.

For a fuller account of experiments being undertaken, other publications are available. Each centre prepares an Annual Report written mainly for the farmer and horticulturist, which can be obtained from the Director concerned (address on pp. 66–69). In addition, at the conclusion of most experiments the results are reported in *Experimental Husbandry*, *Experimental Horticulture* or other scientific or technical journals.

Results from Recent Experiments

POTATOES: BLIGHT, WEED CONTROL AND CULTIVATIONS

F. E. Shotton, *Terrington Experimental Husbandry Farm*

Experimental work on maincrop potatoes is conducted at Bridget's, Gleadthorpe, High Mowthorpe and Terrington E.H.Fs. Many subjects are currently under investigation; seed production and storage, irrigation, weed control and cultivations, disease control, row width, seed size and planting distances. It is not possible to summarize all the work in this article which will deal with aspects of disease and weed control and with cultivation techniques.

Techniques of Potato Blight Control

Losses from potato blight fall into three categories: (1) Infection of the haulm which shortens the active life of the foliage and thus reduces the total crop yield; this applies to most varieties, including both King Edward and Majestic, although certain varieties such as Pentland Dell at present show foliage resistance and therefore do not suffer in this way. (2) Infection and consequent rotting of tubers due to spores washed down from infected foliage. (3) Possible further rotting during storage but certainly increased costs of grading blighted tubers out of the ware. The last two types of loss will be greater for the tuber-susceptible varieties, such as King Edward, than for Majestic which shows a marked degree of field resistance to tuber infection.

The timing of spray applications

Recent trials at Terrington and Bridget's have been primarily directed to a reduction in the losses under (1) though records have always been taken of diseased tubers also. The Terrington trials from 1954–63 with King Edward were reported in *Experimental Husbandry No. 12.* Perhaps the most interesting part of this report is that which deals with the comparisons between the effectiveness of routine sprays of copper oxychloride with sprays of the same material applied for the first time on receipt of the Blight Warning for the district and, subsequently, only when a minimum quantity of rain (0·4–0·6 in.) fell within a period of not more than five consecutive days. The results showed that, taken over the five year period, an average of five sprays applied at routine ten day intervals from the end of June or early July gave no increase in saleable ware as compared with unsprayed plots, whereas the rainfall-timed programme (which involved an average of only 3·6 sprays per year) produced an increase of 0·56 tons of saleable ware. The explanation advanced for these findings is that the increased yields obtained from routine spraying in years of severe blight (e.g., 1960) were offset by reduced yields occasioned by 'copper shock' in years when blight was less severe. Most damage seemed to result from the early precautionary sprays applied to soft foliage but damage also occurred when the foliage had been punctured by aphids or damaged by wind or hail. Rainfall-timed sprays

gave better yield increases than routine sprays in years of severe blight (indicating the desirability of renewing the cover of fungicide at times when further blight spread under humid conditions is likely to be rapid) and also caused less 'copper shock' in years when blight was less severe (mainly because the early precautionary sprays were omitted).

These experiments were therefore successful in indicating an improved technique of using a material such as copper oxychloride which, while an excellent fungicide, suffers from the drawback that, under certain conditions, it may itself reduce yield more than a mild attack of the disease. During recent years new materials have been introduced which appear not to have this disadvantage. These are the dithiocarbamates—zineb, maneb and mancozeb.

Copper oxychloride compared with newer fungicides

At Bridget's E.H.F. from 1961–64 a comparison of copper oxychloride with maneb was made over three spraying systems compared with an unsprayed control, using the variety Majestic.

Treatments were:

1. No spraying.
2. Three routine sprays at three week intervals starting in the first week of July ('Routine' system).
3. First spray applied immediately following the warning of blight outbreak, subsequent sprays at 14 day intervals or when ¾ in. rain had fallen since the last spray ('Weather' system).
4. As 3. but with the added precaution of a first routine spray in the first week of July ('Insurance-plus-weather' system).

The materials were applied at 80 gal per acre using a tractor-mounted 8-row sprayer as normally used on the farm.

The comparison is rather different from the one made at Terrington, as 'routine' sprays were limited to three sprays a year whereas 'weather' sprays were either applied more frequently or continued somewhat later and averaged 4·3 per year. The 'insurance + weather' system included the first spray of the 'routine' programme and also the full 'weather' programme and averaged 5·0 sprays per year.

On this farm, using Majestic which suffers only slightly from infection of blight in the tubers, all spraying systems increased yield over the unsprayed control. Maneb gave better results than copper on all spraying systems and, averaged over four years, produced 0·6 tons per acre more ware than copper sprays and 1·2 tons per acre more ware than the unsprayed control. The only year when spraying failed to increase yield was 1962 when blight appeared relatively late and progressed slowly.

The differences between spraying systems were not great but the 'weather' system gave the best results and produced on average 0·2 tons per acre more ware than the routine system, whether the spray material was copper or maneb. With both materials the 'insurance + weather' system produced a lower mean yield than the 'weather' system. This means that including a first routine spray, as a precaution against an attack of blight before the official warning, in no way improved upon the 'weather' system.

In trials at Terrington 1962–65 comparisons have been made between

copper oxychloride, dithiocarbamates and organo-tin compounds. Over the four years the carbamates (mancozeb, maneb and zineb) never reduced yields below those of unsprayed control. In 1963 and 1965, when copper oxychloride, applied at routine intervals, gave an average increase of 0·9 tons per acre of ware, mancozeb applied in the same manner gave an average increase of 3·0 tons per acre. With such materials the advantage of the rainfall-timed system, which was found in the earlier trials with copper oxychloride, was usually not obtained and in fact, when mancozeb was used (1963–65), the more numerous routine sprays gave better yields by an average of 0·66 tons of ware per acre. With mancozeb, therefore, the problem at the moment seems more straightforward than with copper oxychloride: over-zealous spraying seems unlikely to reduce yield and the only problem is to ensure that the increase in yield is adequate to cover the cost of the material and its application, and to give a measure of profit, which in the trials under consideration would certainly have been the case.

Our present information is that tin (fentin hydroxide) is inclined to behave like copper. In 1965 a foliage scorch occurred on plots sprayed with tin, though this was less serious than that caused by copper. This scorch did, however, reduce total yield (compared with mancozeb) and fewer sprays, timed according to rainfall, produced a ton higher total yield than more frequent routine sprays. On the other hand, fentin hydroxide gave such very good control of tuber blight that five sprays of tin produced (from a lower total yield) about a ton an acre more saleable ware than seven sprays with mancozeb.

Observations in 1964 and 1965 on the use of a helicopter showed that, with maneb results were almost identical, whether the materials were applied from the helicopter at ultra-low volume or by land machine at 50 gallons per acre. This comparison excludes consideration of damage done to crops by tractor wheels which has been shown, at Terrington, to amount to a loss over the whole field of about 0·5 tons per acre, depending on the width of the spray boom. No such loss would occur with aerial spraying and this would help to offset the higher cost.

Present conclusions from both Bridget's and Terrington trials are that copper oxychloride is now outdated and its use should be discontinued in favour of the newer materials. When the variety is Majestic, which does not suffer badly from tuber infection, maneb or mancozeb might be the materials of choice. For a variety like King Edward, whose tubers are highly susceptible to blight, the organo-tin compounds may offer an especial advantage, due to their apparent superiority in controlling tuber infection. Scorch may, however, present a problem with the tin compounds especially if aphids are present and a carefully timed system of spraying related to rainfall may be found to give the highest yield with this material.

Date of haulm destruction

In the 1964 and 1965 Terrington trials the date of haulm destruction on crops of King Edward was also examined. The intention was to kill off with sulphuric acid when foliage blight, on plots treated with mancozeb, reached 1–5 per cent, 10–20 per cent and about 50 per cent. The year 1964 was dry and, although blight was present, accurate recording was difficult owing to haulm death from other causes. Blight was generally more serious in 1965

but was kept under good control in the trial and haulm destruction occurred at 1, 2 and 5 per cent stages. Results were as follows:

Date of haulm destruction	Foliage blight per cent	Yield—tons per acre Saleable ware	Blighted tubers	Total yield
1964				
20 August	5	9·3	—	11·96
31 August	about 10	9·5	Tr.	12·36
Not killed off	over 10	9·8	Tr.	12·42
1965				
18 August	1	13·6	0·6	18·1
6 September	2	15·4	2·3	21·4
23 September	5	16·2	1·7	21·3

In neither year was the yield of saleable ware increased by early burning off, even though tuber blight increased markedly between 18 August and 6 September 1965. This is not to say that there are not years when earlier killing off, even if it reduced total yield, might not increase the out-turn of saleable ware: 1960 was probably such a year. But our feeling, which is supported by these two years' results, is that such years are probably infrequent. For Terrington conditions, early September is probably usually the right time to kill haulm in preparation for lifting but undue prolongation of growth, by a very extended programme of fungicide sprays, would not be considered wise.

Early burning-off may be justified by reasons other than disease control: the wish to prevent tubers of a variety such as Majestic from growing too big and cracking and becoming unsaleable in certain years, is such a case.

Techniques of Weed Control

It has recently been possible to summarize experiments at Bridget's, Gleadthorpe and Terrington from 1961–65 on the comparison of chemical herbicides with traditional mechanical weed control techniques in the potato crop. Most of the trials were concerned with maincrops and these notes will deal only with such varieties. It is clear from these results, and from those of other workers, that it would be pointless to attempt to present an average conclusion from these trials: the trials have given variable results and it is of far greater importance to try to understand the reasons for these variations.

The broad picture is that at Bridget's herbicides have only once in three years given a higher yield than the normal fairly lenient system of cultivations and therefore, in view of the extra cost of the herbicides, the new technique is judged to be uneconomic. The same conclusion has been drawn from observation trials at High Mowthorpe. In clear contrast, at Gleadthorpe and at Terrington, herbicides have given yields superior to those obtained by cultivations. However, when crops at Gleadthorpe were irrigated, the general level of yields rose and herbicide sprayed plots under these conditions yielded less well than cultivated plots.

Ridge form

At all three farms the yield from sprayed plots has been greater from larger than from smaller ridges (in 16 out of 20 comparisons) whereas, on

the other hand, in 13 out of 15 comparisons, at Gleadthorpe and Terrington, the yield from unsprayed plots was larger when ridges were smaller. In each case the mean difference due to ridge form was about 1 ton per acre. This information is taken to mean that more cover over the developing tuber is advantageous, if residual herbicides are to be used, as it will place a greater barrier between the potato and the potentially harmful chemical. The same factor may in part explain why herbicides showed up less well under irrigation at Gleadthorpe: irrigation would tend to wash more chemical down into contact with the crop's roots.

In part, however, these Gleadthorpe results may be explained by the fact that irrigation would make up water losses caused by cultivations and, to that extent, overcome some of the damage done by them. Similarly, the superior performance of smaller ridges when herbicides were not used is probably not a direct effect of reduced soil cover but of the less vigorous cultivations needed to build the smaller ridges causing less moisture loss and being less damaging to crop roots.

It has not been possible to advance any clear explanation of why the Bridget's and High Mowthorpe results differ from those at Gleadthorpe and Terrington. Both these farms lie over chalk but the top soil is a loam intermediate in texture between the Gleadthorpe loamy sand and the Terrington silty loams and silty clay loams. The difference does not appear to be due to the choice of chemical nor to the time of application of the chemical. Cultivations differ on different farms and this could be the reason for the differing results obtained. The large yield differences, which resulted from varying ridge size, indicate how variations in cultivations can influence yield.

Cultivation techniques

Recent trials at Terrington are looking in greater detail into variations in cultivation technique to assess the effect both on yield and on ease of harvesting. In three trials differences of $\frac{1}{2}$ to 1 ton per acre have occurred when final ridging has taken place at different times and in all cases the advantage was in favour of earlier ridging. Nor were the dates of ridging in any way extreme (1964—King Edward: 25 May *versus* 4 June; 1964—Pentland Crown: 26 May *versus* 10 June; 1965—Pentland Crown: 25 May *versus* 31 May). Other cultivations also varied in these trials but it seems probable that it was the ridging, which is a deep and vigorous operation, which mainly accounted for the yield differences.

It seems clear from these, and from other people's trials, that cultivations in the potato crop—once the crop is up—are liable to cause damage. The lighter they are and the sooner they are completed the greater is the yield likely to be. If it is essential to work deep between the rows after the crop is planted in order to improve drainage or increase the depth of tilth, such operations should be carried out as soon as possible after planting. This will also give the greatest chance for any moisture loss to be made good by subsequent rainfall as well as reducing damage to crop roots.

BARN DRIED HAY VERSUS WILTED SILAGE

J. MacLeod, *Bridgets Experimental Husbandry Farm*
and M. J. Strickland, *Great House Experimental Husbandry Farm*

Trials have been carried out over three seasons, at Bridget's and Great House E.H.Fs, comparing the relative efficiencies of barn dried hay or wilted silage as conservation systems and their production potential when fed to dairy cows during the winter.

Conservation

Bridget's E.H.F.—1962 *to* 1964

In each of several fields areas were allocated to either system to provide comparable bulks of material. The grass was cut at the 'silage' stage of growth (early heading) in mid May and both systems were started simultaneously. Once under way, each system then progressed at its own speed. Records were kept of the losses of D.M. and nutrients, the inputs of labour, machinery and rates of work. An assessment of the total costs of production was made per lb D.M. and per acre, including cost of growing the grass, labour, machinery, running costs and depreciation etc. Both forages were made from three year leys, either timothy/meadow fescue or a Cockle Park type mixture. The leys were given 10 cwt of basic slag per acre in the first year, 1 cwt of muriate of potash per acre each autumn and 80 units of nitrogen per acre each spring for their conservation cut.

The hay was cut with a five foot mower and crimped soon after cutting. It was crimped again for a second time the following day. For subsequent conditioning a double swath overshot tedder was used. When the dry matter reached 60 per cent it was rowed up and baled in twenty inch bales of medium density. These were loaded into high sided four wheeled trailers by a tractor-mounted 'Manless' grab and transported to the barn. The bales were elevated into the storage barn drier and hand-stacked cut edge down. Drying was completed with a 50 h.p. diesel moisture extraction unit, without additional heat.

The silage crop was cut with a five foot mower and allowed to wilt for up to twenty-four hours until the dry matter had risen to between 25 and 30 per cent. It was then picked up with a double chop harvester and carted in tipping trailers, dumped on a concrete base and buckraked into a clamp. A fifty-fifty mixture of molasses and water was added to the silage at the rate of two gallons per ton of fresh material. During and after filling, the pit was rolled to keep the temperature below 90°F (32·2°C) and to consolidate the silage. It was then covered and sealed with 200 gauge polythene.

The field yield at cutting was estimated by weighing and sampling known areas of swath. Yields at other stages were determined by weighing and sampling every load into and out of store. To enable comparison of the systems, all yields have been considered as yield of D.M. per acre. Thus a yield of 29·2 cwt per acre of hay out of store at 87·9 per cent dry matter is equivalent to 25·7 cwt per acre of D.M. and 74·2 cwt per acre of fresh silage out of store at 26·4 per cent D.M. equals 19·6 cwt of D.M. per acre.

Yields/acre (3 *years average*)

	Barn dried hay			Wilted silage		
	D.M.	S.E.*	C.P.	D.M.	S.E.*	C.P.
Yields in cwt/acre						
At cutting	31·6	14·8	3·8	28·2	13·8	3·7
Into store	26·8	12·2	3·3	25·6	12·5	3·3
Out of store	25·7	11·5	3·1	19·6	9·4	2·8

*Calculated from estimated values in the dry matter.

Although several areas in each field were allocated to each system to give equal initial field yields, the yields of the later cut areas were greater for hay than for silage, because the hay system was slower than the silage and thus increased the mean yield at cutting. This greater dry matter yield of hay led to a high initial yield of estimated starch equivalent and crude protein and this difference was increased by the relatively high in-store losses of nutrients

Percentage losses (3 *year average*)

	Barn dried hay	Wilted silage
D.M. losses per cent		
In swath	14·7	9·0
In store	3·4	21·1
Total	18·1	30·1
Nutrient losses per cent		
Starch equivalent (to feeding)	21·9	31·3
Crude protein (to feeding)	17·7	23·4

with the silage. Most of the D.M. loss in the hay system took place in the swath, with further small losses in store; with silage, a third of the D.M. loss occurred in the field and a further two-thirds in store. Overall, the hay system was 12 per cent more efficient in preservation of D.M. than the silage system, 9·6 per cent more efficient for starch equivalent and 5·7 per cent for crude protein.

The relative costs of making hay and silage

The costs involved in any fodder conservation system will depend on the resources of the farm and the equipment used. Any figures quoted for the Bridget's experiment will tend to apply to the techniques applied at that farm. In order that the costs may be compared with other farms, the costs of hay and silage making have been divided into two classes, fixed and variable costs. Fixed costs, i.e., tractors, labour etc., may be regarded as overheads, since these resources may be used for other purposes on the farm, whereas the variable costs are directly attributable to the conservation systems themselves. The fixed resources used at Bridget's are given overleaf.

Fixed-cost resources used (excluding labour)

	Barn dried hay	Wilted silage
Fixed equipment	1 Dutch barn fully clad to the eaves on three sides, equipped with removable front cladding, welded wire mesh false floor and air duct.	1 bunker silo with roof and 7 ft high concrete retaining walls.
Machinery	4 tractors 1 mower 1 crimper 1 tedder 1 side rake 1 baler 1 mechanical bale-loader 2 four wheel trailers 1 bale elevator 1 50 h.p. diesel moisture extraction unit.	5 tractors 1 mower 1 side rake 1 double-chop forage harvester with molasses applicator. 2 two wheel trailers 1 buckrake

Clearly, the fixed resources will vary from farm to farm so that it is better to compare variable costs on their own. Comparative total costs of conservation may be calculated for individual commercial farms, using the variable costs quoted for Bridget's plus the fixed costs appropriate to each farm.

Variable costs of hay and silage making

	Barn dried hay	Wilted silage
	£	£
Grassland costs per acre		
Share of ley establishment cost	3·4	3·4
Fertilizer	4·6	4·6
Conservation costs per acre		
Polythene	—	0·1
Molasses	—	0·5
Baler twine	0·6	—
Diesel fuel and lub. oil (for hay drying)	1·7	—
Total variable costs per acre	10·3	8·6
Yield of D.M. per acre out of store in tons	1·29	0·98
Variable costs per lb of D.M. available for feeding	0·86d.	0·94d.

The variable costs per acre were higher with the hay system, but the reduced wastage of crop dry matter with barn hay drying resulted in the cost per lb of dry matter available for feeding being lower for hay than for silage. However, there were considerable differences in inputs of fixed-cost resources between the two systems.

Once the silage operation was under way, with the mower cutting a day ahead of the silage-carting team, there were no bottlenecks and the system ran smoothly, carting continuing daily until the pit was full. With the hay sys-

tem, however, considerable peaks and troughs in labour use occurred, making organization more difficult. Little labour or machinery was required for mowing or conditioning but, when baling, carting and stacking the hay, a large gang was required to keep the system functioning, although often only for an hour or so. In addition, difficulties in drying May-cut grass in the field and the slow potential drying rate of the moisture extraction unit, slowed the the hay system.

Machinery and labour inputs (3 *year average*)

	Yield per acre into store	Hours per ton into store		Hours per acre cleared	
	Tons D.M.	Man hours	Tractor hours	Man hours	Tractor hours
Barn dried hay	1·34	6·3	4·1	8·5	5·5
Wilted silage	1·28	5·1	4·2	6·4	5·2

More tractor time was required to clear an acre for hay than for silage, but this difference ceases to exist when tractor hours are related to the tonnage of D.M. stored. However, the labour demand was higher for hay, both on an acreage and a tonnage basis. If labour is charged at 6*s*. per hour, this represents £2 12*s*. per acre for barn dried hay and £1 18*s*. per acre for silage. However, it must be realized that on different farms this difference in labour demand could have greater or smaller effects on overall labour costs than these figures suggest. For instance, on one farm the reduction of a labour peak at grass-conservation time afforded by adopting silage-making might mean that the farm could be run with less permanent staff than if barn hay drying had been introduced. On another farm, however, this reduction in labour might only amount to less overtime worked or less casual labour hired temporarily.

On comparable acreages the hay system took on average 17 days from mowing the first area to stacking the last in the drier, while the silage system took seven days. In some situations this slower rate of work with hay might result in successive crops being cut at a more mature stage of growth than would be the case with silage-making. The average digestibility of the hay made over a whole season would then be lowered, compared with silage. The potential adverse effect of lowered digestibility upon food intake by cows is described under FEEDING: Bridget's E.H.F.: 1962–64, on page 11.

Great House E.H.F.—1962 *to* 1964

Twelve acres of a timothy/meadow fescue/white clover ley, which had received 80 units of nitrogen and farm-yard manure in the previous winter, were cut in four equal quarters on one day during the first week of June at the pre-flowering stage. Alternate plots were allocated to each system.

The hay was cut with a mower and tedded until the dry matter was 56 per cent, windrowed and baled. The bales were loaded into a coke-fired barn hay drier with a capacity of twenty tons at 60 per cent dry matter. The air flow through the drier was 40 cub. feet/minute/square foot of tray area and

the temperature could be raised 10°F (5·6°C) above air temperature. After drying to 82 per cent dry matter the hay was removed from the drier and stored until feeding.

The silage was cut with a mower and wilted to 33 per cent dry matter before picking up by a full chop forage harvester and filled into the silo by a forage blower. The silo was an experimental box-type with three permanent sides, a concrete floor and drain and a removable fourth side of sleepers. The temperature was taken by thermocouples embedded in the silage. The highest temperature reached before feeding was 90°F (32·2°C). Consolidation of the silage was by treading by foot and railway sleepers. Straw was later loaded on top of the silage.

Efficiency of conservation

	Barn dried hay	Wilted silage
Yields in cwts/acre—D.M.		
At cutting	29·8	29·8
At feeding	23·3	22·2
D.M. losses per cent		
in field	14·5	5·0
in drier	4·6	—
in store	2·8	20·6
Total	21·9	25·6

The overall losses for barn dried hay were 21·9 per cent as against 25·6 per cent for wilted silage, representing an increased yield of 1·1 cwt of dry matter per acre available for feeding. The effluent from the silage clamp was measured each year. In 1962 there were 135 gallons, in 1963 nil, and 1964 18 gallons. The 1964 in-clamp losses were made up of 2·1 per cent visible waste and 18·8 per cent invisible respiration loss.

Feeding

Bridget's E.H.F.: 1962–64

Fodder quality: percent D.M. and analysis of D.M.

	Per cent D.M.	Estimated S.E.	Estimated P.E.	Crude protein	Crude fibre	pH
1962: Hay	85	48	5·8	11·4	31·9	—
Silage	24·2	46	8·6	13·4	30·9	3·9
1963: Hay	85	44	5·7	11·3	29·1	—
Silage	26·8	50	10·5	15·7	30·5	4·2
1964: Hay	84·3	41	8·3	14·0	31·0	—
Silage	25·3	50	11·3	16·7	33·0	4·9

In the first two years the protein equivalent level in the silage was superior to that of the hay and the ratios of P.E. to S.E. in the silages were theoretically better balanced for milk production than those in the hays. In the last year the differences in protein content were very much less marked. In this year the *in-vivo* digestibilities of both these feeds were determined

by feeding them to wether sheep. The average percentage digestible organic matter in the dry matter for the silage was 68·3 per cent and for the hay was 68·0 per cent.

The roughages were also tested in feeding trials with milking cows. In all years barn dried hay fed *ad lib* day and night was compared with silage fed in the same way. In 1962 silage *ad lib* by day plus 10 lb barn dried hay by night was also tested. Changes were made from year to year in terms of concentrate feeding. In 1962, barley was fed at 4 lb per gallon for yields over 2 gallons on average, with the barley being replaced by balanced concentrates for yields over 4 gallons. In 1963, following an indication in the previous year that high-cereal supplementation was only appropriate in the case of silage, the treatments compared were redesigned. All cows receiving hay were fed a high-protein 'balancer' consisting of a 50 : 50 mixture of barley meal and ground nut cake at an average rate of 3 lb per cow per day. The starch equivalent deficiency of the silage was balanced by feeding straight barley meal to all the silage-fed cows at an average of 6 lb per day. The cows on each roughage were divided into two groups: production concentrates at 4 lb per gallon were fed for yields over 3 gallons in the case of one group, as against over 4 with the other. This concentrate feeding was in addition to the 'balancer' concentrates described above.

In 1964 it was decided that the concentrate feeding would be simplified by the use of a standard balanced concentrate containing sufficient protein to ensure that there would be no shortage of this nutrient whichever roughage was fed. Again the trial consisted of two groups of cows on hay and another two on silage. The hay groups received no concentrates at all as against concentrates at 4 lb per gallon for over 2½ gallons, whereas with silage, concentrate supplementation started at 2½ or 1½ gallons.

Results 1962–64, *per cow*

Treatment		Consumption in lb D.M./day:— roughage	concs.	Yield in gal/day	Per cent B.F.	Per cent Total solids	Live weight change
1962							
Hay		31·1	5·4	3·3	3·76	12·35	−1·7
Hay/silage		22·2	5·6	3·2	4·08	12·56	−11·4
Silage		21·8	5·5	3·2	3·96	12·38	−16·0 (over 4 weeks)
1963							
Balanced concentrates over:							
Hay	3 gal	31·2	7·4	4·2	3·64	12·26	+2·0
Hay	4½ gal	38·6	4·3	3·9	3·94	12·55	−9·4
Silage	3 gal	19·7	10·8	4·0	4·07	12·55	−39·0
Silage	4½ gal	21·6	7·3 (including 'balancers')	3·8	4·02	12·36	−104·6 (over 12 weeks)
1964							
Balanced concentrates over:							
Hay	none	26·3	0	2·8	3·93	12·29	−4·8
Hay	2½ gal	25·2	2·2	2·7	4·16	12·56	+6·7
Silage	2½ gal	20·1	2·6	2·8	4·08	12·25	−47·6
Silage	1½ gal	19·2	4·4	2·8	4·69	12·93	−48·4 (over 12 weeks)

In 1962 the trial was a 'change-over' design, in which each cow spent three 4 week periods on the different rations. In subsequent years the trials were of the continuous type in which each cow was fed a single ration for 12 weeks.

In 1962 and 1964 there were no differences in milk yields between treatments, but in 1963 cows receiving silage and 7·3 lb of concentrates yielded significantly less than those fed hay and 7·4 lb concentrates. This suggested that, in the context of *ad lib* roughage feeding, the rate of concentrate supplementation with hay could be less than with silage. The reason for this was evident, not only in that year but also in the others: considerably higher voluntary dry matter intakes were achieved with hay than with silage. Although this effect did not always result in higher milk yields, it could invariably be discerned in the liveweight trends. The cows on hay either gained weight slightly or only lost a little over the trial periods, whereas the silage-fed animals always lost weight to a significantly greater extent. In the first two years butter fat percentage was raised by silage feeding but only in the first year did this result in a higher total solids content.

The overall conclusion suggested by the results of these three trials was that with *ad lib* feeding, the greater dry matter intake with barn dried hay could be exploited by economizing on concentrate feeding. However, it must also be recognized that, in certain farm situations, the consumption of large quantities of high quality roughage is not desirable. In these circumstances it would be necessary to ration barn-dried hay and supplement with concentrates accordingly and this would nullify the intake advantage of barn-dried hay.

In 1964 the cows were fed individually and it was possible to investigate the factors influencing dry matter intake of the roughages. With hay the major influence was digestibility. On the hay without concentrate group the following range of intake was observed.

Hay (listed in order of cutting date)	*In-vitro* percentage D.O.M. in D.M.	Average intake of D.M. in lb per day per cow	Average intake of D.O.M. in lb per day per cow
H1 and H2 (13 and 15 May)	71·8	32·3	23·3
H3 (16 May)	72·0	31·4	22·7
H4 (17 May)	69·6	30·6	21·3
H5 (21 May)	64·9	25·8	16·7
H6 (27 May)	60·0	18·7	11·2

Not only did the low digestibility reduce the intake of D.M. but also drastically reduced the intake of digestible organic matter. Although a cow fed H6 would eat 58 per cent of the D.M. consumed when fed H1 *ad lib*, the intake of D.O.M. on H6 would only be 48 per cent of the intake on H1.

Great House E.H.F.—1962–64

In all three years the fodders were evaluated by a 'change over' trial over a four week period. The first week was a preliminary period; the second was the first trial period, during which half the cows were fed silage and the other half hay; the third was a cross-over week and the fourth week was the second trial period in which each of the two groups of cows were fed the opposite type of roughage to the one they had received during the first trial period. Concentrates were allocated on the basis of the yield during the week before

trial and fed at 4 lb per gallon for yield above 2 gallons. In 1962 the fodders were fed *ad lib*, but in 1963 and 1964 they were restricted, so that the dry matter intake was the same for both hay and silage.

In each year the digestibility of the hay and silage was measured by feeding to wether sheep. The results are given in the following table:

Percentage Digestibility of Organic Matter in the Dry Matter

	Barn hay	Silage
1962	71·2	72·5
1963	67·5	68·5
1964	60·4	61·7

Results—Per Cow

Treatment	Concentrates over	Per cent D.M. of roughage offered	Consumption in lb D.M. per day		Yield in gal per day	Per cent B.F.	Total solids
			Roughage	Concentrates			
1962							
Hay	M + 2	85·2	25·1	5·8	3·47	3·76	12·26
Silage (*Ad lib*)	M + 2	30·1	19·7	5·2	3·22	4·03	12·36
1963							
Hay	M + 2	84·0	17·5	8·2	4·19	3·33	11·98
Silage (Restricted)	M + 2	39·2	17·6	7·7	3·88	3·56	12·04
1964							
Hay	M + 2	83·8	17·0	5·4	2·96	3·59	11·96
Silage (Restricted)	M + 2	23·2	17·0	5·4	2·90	3·82	12·14

The milk yield was higher on the hay treatments than on silage while the butterfat percentage was higher on the silage feeding regimes than on hay.

Under the *ad lib* feeding of 1962 both hay and silage were utilized less efficiently, since only slightly more milk was produced from a much higher dry matter intake than under the restricted feeding of 1963 and 1964.

Conclusions from Both Farms

Barn-dried hay was a more efficient method of conservation from the crop wastage point of view, giving a greater yield of available fodder than silage. Although hay was more expensive per acre, the greater yield eliminated this difference at feeding. However, it was necessary to restrict intake of hay by cows, in order to avoid luxury consumption, which gave little benefit in terms of milk yield, the only observable effect being reduced losses of body weight during early lactation. When trying to conserve a large acreage, as at Bridget's, the technical and managerial difficulties operated against a hay system and silage making in conjunction with *ad lib* feeding gave practical advantages. Furthermore, with hay, the reduced rate of clearing the acres with a given size of team, compared with silage, could well be expected to result in an overall increase in the maturity of the produce and hence a owering of its quality, over a whole season. However at Great House, where conservation involved smaller acreages easily handled in a short time, the hay system with restricted feeding in winter was preferable to silage.

PLANNED WATERING AND FEEDING OF GLASSHOUSE CARNATIONS

Derek R. Smith, *Efford Experimental Horticulture Station*

When experience and experiment have indicated the main environmental needs of a glasshouse crop, one of the major tasks of the Experimental Horticulture Stations is to use the control equipment they possess to provide the optimum conditions for rapid growth and satisfactory cropping. This, to a large extent, makes it possible to take the craftsmanship out of growing, replacing it with a known set of conditions to be followed for producing a desired end-product.

When equipment for controlling levels of temperature, irrigation and nutrition can be automated, this provides even greater precision and saves a great deal of labour. Further, it enables the preparation of a cultural 'blueprint', which may be written in advance of sowing or planting, and followed, virtually without alteration, by largely unskilled labour, right through the life of a crop.

Using all the information then available, such a blueprint was prepared before planting, in June 1963, the first crop of perpetual-flowering carnations grown at Efford. They were planted in unlined beds, with base fertilizer added to the top eight inches of soil at the rate recommended for a J.I.P. 1½ compost. The primary aim of the investigation was to compare growing temperatures which could be quite accurately controlled by automatic heating and ventilating systems already proven with other glasshouse crops. The remaining major consideration was that of irrigation and, coupled with it, nutrition. A trickle system was chosen because of its slow and even application of water without splashing, and had previously been shown to be half as dangerous in spreading *Verticillium* wilt disease as hose watering.

But how much water was to be applied, and who was to decide the quantity and frequency of irrigation? It was important that these details should be described and that the watering regime should be reproducible. Since the beds were unlined, daily watering seemed unnecessary and thrice-weekly, or fewer, applications seemed suitable. Tomatoes and, more recently, chrysanthemums, had been satisfactorily watered on the Station on the basis of the relationship which research had shown between the amount of solar energy received by a crop and the amount of water lost from foliage and soil as a result. This had led to the issue of the N.A.A.S. weekly 'water figure' for the guidance of tomato growers, Efford being one of the centres where solarimeter records are kept and the water figure calculated. From a month after planting, this figure was used for irrigating carnations, but the 70 per cent utilization factor employed in the tomato calculation was increased to 100 per cent. Table 1 relates the N.A.A.S. weekly figure with that used for

TABLE 1

Correction of the N.A.A.S. weekly tomato water figure when used for carnations of different heights in unlined beds

Plant height (in.)	6	9	12	15	21	33+
Percentage of issued figure	71	86	93	100	110	142

carnations of different heights up to estimated full ground cover, when the plants were about 33 in. tall. Metered watering was done on Mondays, Wednesdays and Fridays during the summer, reduced to perhaps once weekly in winter, when the water requirement was much less.

Adding a fertilizer dilution bottle to the system allowed the addition of nutrients to all routine irrigation. Although some carnation growers modify the composition and strength of liquid feeds on a seasonal or even a weekly basis, according to experience, research had suggested that carnations took up nitrogen and potash in the approximate proportions $1 \cdot 25N : 1K_2O$ throughout the year. A fertilizer concentrate was made up (Table 2), to supply $1 \cdot 3N : 1\ K_2O$, and was used unaltered throughout the life of the crop. The standard dilution rate of 1 : 200 was weakened only on two occasions to counteract hard growth and the plants responded in two or three weeks.

TABLE 2

Composition of liquid fertilizers used for continuous feeding of carnations receiving calculated amounts of irrigation water

Stock solution			Dilute feed			
Type	Weight (lb) fertilizer per 10 gal water		Rate	Nutrient concentration p.p.m.		Ratio $N : K_2O$
	Ammonium nitrate	Potassium nitrate		N	K_2O	
1. Original	16	12½	1 : 200 1 : 300	360 240	280 190	1·3 : 1
2. Modified	10½	9	1 : 200 1 : 300	240 160	200 130	1·2 : 1

Under these conditions, and at a night temperature of 48°F (8·9°C), four varieties averaged a yield of 53 blooms per sq. ft of bed during the first 12 months' cropping. But soil analysis did show a build-up of soluble salts at the fertilizer strength used and an occasional watering without fertilizer was necessary to flush the beds.

Thus, both watering and feeding had been achieved according to a pre-planting specification, adhered to throughout. But watering was still only semi-automatic, in that a tap had to be turned on and off and a water meter watched. With a second carnation crop, this time of virus-tested clones planted in watertight beds in January 1966, watering was completely automated by the use of a small evaporimeter (Plate V). This had been introduced some ten years earlier for controlling mist irrigation in amateurs' glasshouses and had been very little used commercially. The addition of a control unit (Plate V) meant that the system could be calibrated to match the calculated water figure, with the duration of each irrigation limited to multiples of five minutes. This has meant much smaller amounts of water given much more frequently, thus suiting beds with a limited capacity for water before natural drainage occurs. It has been found easier to match the calculated figure in summer than in winter. Using a modified liquid feed (Table 2), yields of up to 33 blooms per sq. ft, have been obtained from vigorous, virus-tested stock during the first three months of picking. Pests have been

controlled with routine Metasystox drenches applied through the irrigation lines. Manual work with this crop is now limited to supporting, disbudding and picking, with an occasional overhead spraying.

Glasshouse carnations are now joining the growing list of 'precision-grown' crops for which a cultural 'blueprint' can be prepared in advance for the guidance of staff, thus relieving them of the problem of making day-to-day decisions.

AUTUMN TOMATOES

A. E. Waterfield, *Lee Valley Experimental Horticulture Station*

In 1966, three late tomato crops were grown at the Lee Valley E.H.S. in order to extend the season for English tomatoes, to reduce the amount of labour normally required during July to September (for training a long term crop) and to determine the value of normal and high density tomatoes for autumn production.

Experiments earlier in the year had shown that from an early sowing a yield of 45–50 tons per acre could be produced by the first week of July and in two houses the crops were then terminated and replanting took place between mid to end July. In two other houses, which had grown antirrhinums and stocks maturing in late spring, tomatoes were planted towards the end of June for harvesting from early September to the end of October.

Autumn Crop at a Normal Density

The plants were grown at the normal density (14,000 per acre) on lines of straw bales and in capillary beds, which had been used for the previous crop of tomatoes.

Sowing	28 June
Planting	29 July
First harvest	29 September
Last harvest	29 November

Yields ranged from 13 to 20 tons per acre and the mean yield for each variety is shown below:

Moneycross	17·6 tons
Eurocross BB	16·9 tons
Eurocross B	15·8 tons
Ware Cross	14·8 tons

Autumn Crop at a High Density

The crop was grown at a density of 24,500, 21,500 and 15,500 plants per acre on wide straw beds which had grown a previous crop of tomatoes terminated in mid-July.

First sowing

Sowing	29 June
Planting	14 July
First harvest	6 October
Last harvest	1 December

The mean yield for each variety was as follows:

Eurocross BB	19·5 tons
Moneycross	18·3 tons
Ware Cross	16·1 tons

Second sowing

Sowing	6 July
Planting	20 July
First harvest	17 October
Last harvest	1 December

The mean yield for each variety was as follows:

Eurocross BB	14·5 tons
Moneycross	12·7 tons
Ware Cross	10·3 tons

Autumn Crop Following Antirrhinums and Stocks

In this case the tomatoes for autumn production were planted earlier as they followed antirrhinums and stocks, which were cleared by mid-June.

Sowing	3 June
Planting	23 June
First harvest	1 September
Last harvest	24 October

The crop was grown at a high density with the plants at 21,600, 18,500 and 14,250 per acre in heated or unheated glasshouses. The plants in the heated house were grown on wide straw beds and in the border soil. The plants in the unheated house were grown only in the border soil.

Yields of 20 to 30 tons per acre were obtained and Ware Cross gave a mean yield 5 tons greater than Eurocross BB. The two higher plant densities gave a greater yield than the lowest density and there was little difference in yield between straw beds and clean border soil in the heated house. The crop in the unheated house was reduced considerably and yields varied from 11 to 15 tons per acre. Ware Cross was affected by leaf mould, particularly in the unheated house, but it still gave a higher yield than Eurocross BB.

With each crop grown at a close spacing the plants at the higher densities gave a slightly heavier yield than those at the lowest density. Time of sowing is very important if a good yield is to be obtained and the following yields from Eurocross BB at a density of 21,500 plants per acre when sown on three dates emphasize this:

Sowing date	*Yield*
3 June	23·8 tons per acre
29 June	19·3 tons per acre
6 July	14·3 tons per acre

Late Autumn crops are more subject to leaf mould and the results confirm that a variety resistant to leaf mould is well worthwhile.

SCREENING NEW CHRYSANTHEMUM VARIETIES

S. Jubb, *Stockbridge House Experimental Horticulture Station*

Variety trials have always been an important part of the work of Experimental Horticulture Stations, and much had already been done on the assessment of chrysanthemum varieties before the new trial was started at Stockbridge House in 1962. The earlier trials were usually concerned with varieties that had been on the market for some years. These trials took time to conduct so that, when final results were published, they were of limited value since the grower had often made up his mind already on the merits of the varieties tested.

The new trial was instituted to give a quick assessment of the potential of current year's introductions, 'Novelties', and to compare these with established varieties of known performance. New introductions are offered in profusion in Breeder's and Introducer's annual catalogues. Whatever the merits of a new variety, it is obvious that not all introductions will be of use to the cut-flower industry. Many are more suitable for exhibition or garden decoration.

The grower of chrysanthemums for sale as cut bloom is in a competitive business and has to keep up, not only with current trends in flower colour and form, but also with those varieties that will increase the profitability of his business. How is the cut-flower producer to choose what varieties he shall grow? He must be alert both for new varieties to meet changing fashions and to keep abreast of his competitors. He must also grow at a profit. Given that a new variety is of a form and colour that he can sell, he will want to know how many blooms per plant he can expect. If a low number, then perhaps the plants can be grown closer together to maintain high production per sq yd. He will want to know how well blooms maintain their size as cutting proceeds. Two good flowers per plant followed by three very inferior ones is of little commercial use. Stem length is important. Supports are expensive and a tall variety is more difficult to disbud and harvest. If a variety is also straggly then the plant is almost impossible to manage. Foliage that is large, too abundant, or brittle, will increase packing costs.

Varieties that damp readily, take mildew, or are susceptible to insect pests, will prove costly to keep clean. Weak-rooted varieties need more care in growing and thus tend to increase costs. A tendency to shatter or the inability to take up water have spoiled the commercial prospects of many varieties. A variety that will harvest over a short period enabling it to be cleared, and the area to be cropped with something else, is a desirable feature. Apart from appearance, these considerations may well amount to the difference between profit and loss on the crop, and must be taken into account.

If a grower buys in 'Novelties' at up to 7*s.* 6*d.* per plant, he will need at least 12 plants for a valid assessment and if he obtains 20 varieties the cost is quite high. If he discards 18 of these varieties after the first year as unsuitable to his business, a considerable loss is involved. It was to answer these points that the Stockbridge House screening trial was started in 1962. Each

season's introductions are flowered under similar conditions and compared with varieties of known merit ('Standards').

Records are taken of plant height, crop production, size of bloom and susceptibility to pest and disease. As varieties come into bloom, they are assessed by a panel of three prominent cut-flower growers from Lancashire and Yorkshire, together with representatives from the Yorks. and Lancs. N.A.A.S. Regional Headquarters, Fairfield and Stockbridge House E.H.S's. Varieties are allocated to three categories:—

'E.T.'—Extended Trial, for varieties of merit
'T.A.'—Try Again for doubtful ones
'R'—Rejected, for those not considered an improvement on existing varieties.

At the end of the season results are published in a Station Leaflet, which is available to growers on application to the Director of Stockbridge House E.H.S., in time for varieties to be purchased and grown in the year following introduction.

The quick assessments made in these trials have certain limitations. Varieties do not always live up to their early promise, but the leaflet offers the grower a factual alternative to visiting breeders' nurseries or chrysanthemum shows during the long flowering season. 'E.T.' and 'T.A.' varieties continue to be grown at Stockbridge House and are assessed annually until faults show up and they are rejected, or, if they continue to perform well and are placed in the 'E.T.' category three times, then they are 'Approved'. At the same time, cuttings of 'E.T.' varieties are sent to other Experimental Horticulture Stations for trial under other climatic and cultural conditions.

Growing methods

The trial is conducted in a Dutch-light structure that can be heated when natural temperature falls below the level desirable for chrysanthemums. Twelve plants of varieties considered suitable by the raisers for cut-bloom production are purchased in early April and bedded in a frame alongside standard varieties and others which have been chosen for extended trial and retrial from previous years.

All varieties are planted at 12 in. × 12 in. in the flowering house in early May, irrespective of flowering season; in consequence, later varieties often grow taller than they would normally. Pest and disease control presents a difficult problem with material coming from so many different sources. Insecticides, which are acceptable for some varieties, cause damage in others. As little use as possible is made of fungicides as it is most desirable that natural resistance to mildew and damping should not be masked. The blooms cut from these trials are, if necessary, kept in cold store for the Panel meetings which are usually held on four occasions during the flowering period from August to December.

Results

In Table 1 are listed varieties 'Approved' so far (this can apply only to varieties introduced in 1964 and previously). This table indicates a limitation of the trial. A variety may not show aspermy or other trouble until after it has been approved, but may subsequently deteriorate quickly. This is so with the varieties Good Morning and Pink Mist; both are excellent if virus-free, but susceptibility to serious maladies lowers their commercial value. Simil-

TABLE 1

Chrysanthemum variety testing—Approved Varieties

Variety	Introduced by	Type	Colour	Harvest period	Flowering ht (in.)	Blooms		Comments	Year approved
						Mean No. per plant	Mean dia. (in.)		
Wells Salmon	Wells	Inter	Pink	Aug–Sep	40	3·4	4·4	Not a strong plant but usually prolific	1954
Purple Gem	Amiel	Inter	Purple	Aug–Sep	51	5·2	5·6	Not a strong plant but very prolific	1964
Joanna Lee	Moody-Rowe	Inter	Pink	Sep	46	5·2	4·9	Extremely prolific strong plant, susceptible to mildew	1964
Eric Bedser	Shoesmith	Reflex	Yellow	Sep	48	3·3	4·6	Good quality reflex, reliable	1964
Dora May	Moody-Rowe	Inter	Pink	Sept–Oct	55	4·1	4·5	Very good colour	1964
Pinkie*	Elm House	Spray	Pink	Sep–Oct	37	†4·9	13·3	Good where spray is required	1964
Golden Galleon	Shoesmith	Incurve	Yellow	Oct	54	2·6	5·3	Still an outstanding yellow	1964
Virtue	Rowe	Inter	Pink	Oct	37	3·8	3·9	Appears very susceptible to *Phoma* sp.	1965
Super Star*	Johnson	Reflex	Red	Oct	58	5·4	4·7	Good red, petals may burn in hot sun	1964
Good Morning	Riley	Inter	Pink	Oct	56	3·1	4·6	Should be grown only when virus-free is obtainable	1964
Pink Mist*	Rowe	Inter	Pink	Oct	50	2·8	5·1	Like Good Morning, very susceptible to aspermy	1964
Anne Riley	Riley	Incurve	White	Oct–Nov	50	2·6	3·8	A large solid incurve	1964
Star Prize	Shoesmith	Inter	Bronze	Nov	58	3·7	4·4	Rather thin, but reliable, light bronze	1965
Jim Plummer	Rowe	Reflex	Red	Aug	39	3·0	4·0	Very good early scarlet	1965
Amber Lad	Johnson	Reflex	Bronze	Sep	42	3·5	4·9	Robust manageable plant, light bronze	1965
Shantung	Rowe	Inter	Buff	Sep	62	3·1	5·0	Robust plant, most appealing buff colour	1965
Maynet Bronze	Amiel	Inter	Bronze	Oct	52	3·9	4·1	May be a little straggly under glass, otherwise good	1965
Rosedew	Woolman	Incurve	Pink	Sep	38	4·7	4·9	A very good strong pink	1966
Good Return	Amiel	Inter	Bronze	Sep	52	2·8	4·9	Flower better than foliage, good colour	1966
Alan Rowe	Rowe	Incurve	White	Oct	60	2·5	4·6	Good reliable white	1966
Sun Valley	Shoesmith	Incurve	Yellow	Nov	37	2·8	4·3	A useful alternative to Yellow Fred Shoesmith	1966

*1964 production figures.

†4·9 sprays/plant; 13·3 blooms/spray.

arly, the susceptibility of the variety Virtue to *Phoma* species has become apparent only after the first three years.

The Panel has tended to set higher standards with experience, realizing that growers will still have a wide choice. Some 3,000 varieties are listed in the National Chrysanthemum Register and more than 100 new varieties appear annually.

In Table 2 the percentage of all varieties placed in each category in the first year of trial is given. In subsequent years the number in the 'E.T.' and 'T.A.' categories, in a particular year, are reduced as faults show up or varieties are superseded by newer introductions. If the trial can speed up the rate at which the better new varieties are brought to the attention of growers, it will have served its purpose.

TABLE 2

Chrysanthemums: variety testing: percentage placed in each category

Year	No. of new varieties	Percentage in each category		
		Extended trial	Try again	Rejected
1962	66	33	37	30
1963	55	24	18	58
1964	48	17	37	46
1965	86	28	19	53
1966	94	30	14	56

Short Notes on Other Experimental Work

IRRIGATION OF FARM CROPS

P. N. Harvey, *Gleadthorpe Experimental Husbandry Farm*

Work on irrigation began at Gleadthorpe in 1955, one of the two really hot dry summers of the past twelve years and a very encouraging season in which to start. The aim of the first experiment was to investigate the responses of sugar beet and potatoes to different methods of watering and to find out whether the effects of irrigation for these crops carried over to the succeeding cereal. Out of the five experimental years there were three wet summers and two very dry ones, 1955 and 1959. Responses in the two drought years were so large that, although watering had no effect in the other three seasons, the five year average exaggerated the benefits to be expected from irrigation if the normal criterion of a ten year average is accepted. This was especially true for sugar beet, the mean yield response for the five experimental years being twice the average recorded from 1955–65, when the results of later work is taken into account. Similarly, although the mean additional weight of King Edward ware resulting from irrigation was about the same in the five experimental years 1955–59 as it was in subsequent experiments in 1960–62, i.e., 3 tons per acre, this represented an increase of 40 per cent in the earlier years but only 20 per cent in 1960–62 because the general level of yield was better. Results such as these emphasize how misleading the results of a few years can be in assessing the long term worthwhileness of irrigation on the farm.

Planning for Irrigation

Water, labour and equipment are all scarce resources which must be husbanded carefully if irrigation is to be economic. Today irrigation research is mainly directed to finding out for each crop when and how to apply a limited amount of water to the best advantage and from this information to plan a cropping programme, so that water is available for each crop in turn at the stage in growth when the plant needs the water most.

Main Crop Potatoes

Experience in watering main crop potatoes offers a good example of how a better understanding of crop development in relation to moisture need leads to a more economical use of water. In the results quoted above the gain from irrigation was about 1 ton of ware per inch of water applied. However, some of this water was 'wasted' in that water was given early in the development of the crop. Main crop varieties have a long growing season and experimental work shows that watering before tuber development is of little value: in one year it was positively harmful, especially for King Edward, a variety which tends to produce a large number of small tubers if watered early in the season. Majestic is less prone to this trouble and, if the weather is very dry after planting, an application of water may be justified.

Early Potatoes

The postponement of watering main crops until after the end of June means that in May and June the equipment can be reserved for early and second early varieties. Early varieties bulk very rapidly during a short growing season when the demand for water is very high. Hence it would be expected that good responses to irrigation would be obtained in most years and this has been the case at Gleadthorpe. Out of the seven years 1960–66, 1965 was the only season when there was no gain in yield from watering Arran Pilot. The average increase in saleable potatoes from irrigation in these years was $2\frac{1}{4}$ tons per acre, or 35 per cent above the unirrigated yield of $6\frac{1}{2}$ tons per acre. At £15 per ton this represents an extra £34 per acre compared with the cost of putting on 3 in. water at £2 10*s*. per acre in., or £7 10*s*. This outcome takes no account of the improved tuber quality which has always been found at Gleadthorpe when potatoes are irrigated. The reduction in scab is clearly marked and it is probable that watering early in the crop's life may be especially important in controlling this disease. Watering to small deficits, which in practice also means giving water before tuber initiation, has not resulted in better yields than the more usual applications of 1 in. of water at a time, but does appear to produce a cleaner sample. In some seasons an early application of water is given as a precaution against frost before moisture need has built up. The object of this emergency measure is to wet the surface soil because wet soil is a better conductor of heat than dry soil. If the type of weather is experienced when warm sunny days alternate with clear frosty nights, the moist surface soil can store heat during the day and radiate it from the ground at night to warm the air around the plants.

The effect of irrigation in reducing the severity of frost damage was strikingly shown after the killing frost of May 1961, when potatoes watered the day before the frost yielded 8 tons per acre as compared with 5 tons from the crop watered the following day. Since that year early potatoes have not been damaged by frost at Gleadthorpe although the crop narrowly escaped a check during Whitsun 1966. Apart from this early precautionary watering, which may also play a part in reducing the incidence of scab, irrigation to a deficit of about 1 in. to $1\frac{1}{2}$ in. appears to be a good compromise that prevents any significant check to the crop but does not entail excessive labour in moving pipes.

Sugar Beet

Sugar beet is widely grown on the light soils that stand to gain most from irrigation and, on much light land, it is the chief alternative to cereals. Nevertheless, beet has a long growing season and is deeply rooted so, although yield responses to irrigation can be spectacular on sand soils in years of prolonged summer drought such as 1947, 1955 or 1959, the crop has a remarkable power of recovery after shorter spells of dry weather. At Gleadthorpe the average gain in the 11 years 1955–65 has been 3 tons per acre worth, say, £19 10*s*. The usual usage of water has been 3 in. which at £2 10*s*. per acre in. cost £7 10*s*. to apply, leaving a margin of £12 per acre. This is a modest return, considering how quickly the sand land at Gleadthorpe dries out, and on less free draining soil the margin would presumably

be less. The responses clearly do not compare with those found for early potatoes or grass, from which it must be concluded that it is not worth while to install irrigation equipment for sugar beet alone but that other high value crops must be brought into the system to justify the capital expenditure.

Cereals

It is commonly stated that cereals come last in order of priority for irrigation when water is limited. However, a possible system, on light soils with access to water, is to farm without livestock or grass and concentrate on potatoes, sugar beet and cereals. Since the equipment is not normally needed for early potatoes until mid May, a proportion of the cereal acreage can be watered before-hand in the hope that an ample moisture supply at this stage will help the crop to keep growing later in the season, even if dry spells set in.

At Gleadthorpe from 1961–64 the average increase in grain yield from a single watering of 1¼ ins. at the late tillering or early boot stage was 3 cwt for both winter wheat and spring barley. Rainfall in the four months April to July was above average in 1961 and 1963, rather below average in 1962 and 2 ins. below in 1964, the season when the maximum response of 5 cwt was recorded for spring barley.

If the variable cost of watering (£1 per acre in.) only is charged against the cereals, it will be seen that the increase of 3 cwt grain was economically justified. In 1960, when April, May and June were exceptionally dry, an observation study suggested considerably more benefit from watering than was found in the more critical experiments in seasons when the rainfall was reasonably well distributed. Theoretically, the maximum gain would be expected if the water were applied at the flowering stage, as has been shown for peas, for example. However, this is scarcely practicable and, in most seasons, the need to give priority in a watering programme to more valuable and responsive crops, such as early potatoes, rules out cereal irrigation after the end of tillering.

NARROW-ROW DRILLING OR BROADCASTING CEREAL SEED

R. Wickens, *Arthur Rickwood Experimental Husbandry Farm*

Two factors have tended to maintain the traditional 7–8 in. coulter spacing of cereal drills. The first, a matter of history, was the need to hoe between the rows; the second, and more recent, reason was the popularity of the combine drill, which requires a reasonably wide coulter spacing to accommodate the fertilizer metering mechanism. With a gradual reduction in the area of phosphate and potash deficient cereal land, the benefit from combine drilling of fertilizer compared to broadcasting is likely to be reduced at the present time. There is now, therefore, a trend towards 'corn only' drills with their attendant increase in hopper capacity and greater speed of work. It has so happened that the most readily available 'corn only' drills have been of continental origin with coulter spacings narrower than the traditional

7–8 in. Claims have been made for enhanced grain yields from crops grown in rows narrower than 7–8 in., although such a claim goes against the general conclusions of Holliday's (1963)* review of world literature on the subject. His conclusion was that plant populations exerted a far more radical effect on grain yields than do reasonable variations in plant arrangement. By this time also work at the Norfolk Agricultural Station had been reviewed by Baldwin (1963)†. He concluded that, with pre-1960 varieties, decreasing the coulter spacing from 8 in. to 4 in. increased the yields of wheat by 4 per cent, barley by 6 per cent and oats by 2 per cent. Similar trials in 1962–64, using modern spring barley varieties and high nitrogen dressings, showed only a 2 per cent benefit for the narrow drills.

It was within these conflicting views that E.H.F. work was started in 1964 to provide additional information on comparative yields from 'normal' and 'narrow' rows when fertilizers were applied by broadcast methods. At the same time, an opportunity was taken to compare yields from broadcast seed with those from drilled seed, also on the basis of broadcast fertilizers.

From 1964–66, 17 E.H.F. experiments were conducted on this general topic covering spring barley (11 trials), winter barley (2 trials), spring wheat (1 trial) and winter wheat (3 trials). The majority of the trials were at Gleadthorpe, High Mowthorpe and Rosemaund E.H.F. with the one spring wheat trial at Drayton.

At Gleadthorpe the comparisons were between 7 in. and $3\frac{1}{2}$ in. row widths, at High Mowthorpe between 7 in. and $4\frac{3}{4}$ in. row widths and at Rosemaund between 7 in. and 4 in. Comparisons with broadcast crops were made at Drayton, High Mowthorpe and Rosemaund.

Eleven of the experiments included both seed rate and nitrogen factors; an additional 2 experiments included seed rate only and 2 more included spring nitrogen only.

It is necessary to describe here the method of conducting the trials, because it influences the calculations used in converting plot yields to yields per acre. In all cases with drilled crops (except the one trial at Drayton) a bare ground guard area was left along both sides of each of the harvest plots to delineate the area for combining. A convention (devised by the N.I.A.B.) of adding to the plot width twice the width of half a guard gap up to a maximum of 18 in. is used to account for this 'dead area' when raising yields to agricultural terms. This convention has been used consistently in E.H.F. cereal work in the past and is in most circumstances thoroughly objective. It has the commendable feature of minimizing the exaggeration which often results from scaling up plot yields.

However, when used in a trial comparing row widths, the use of this convention may very slightly underestimate the difference between treatments. In assessing the value of a 'new' technique, any error will therefore be on the side of caution.

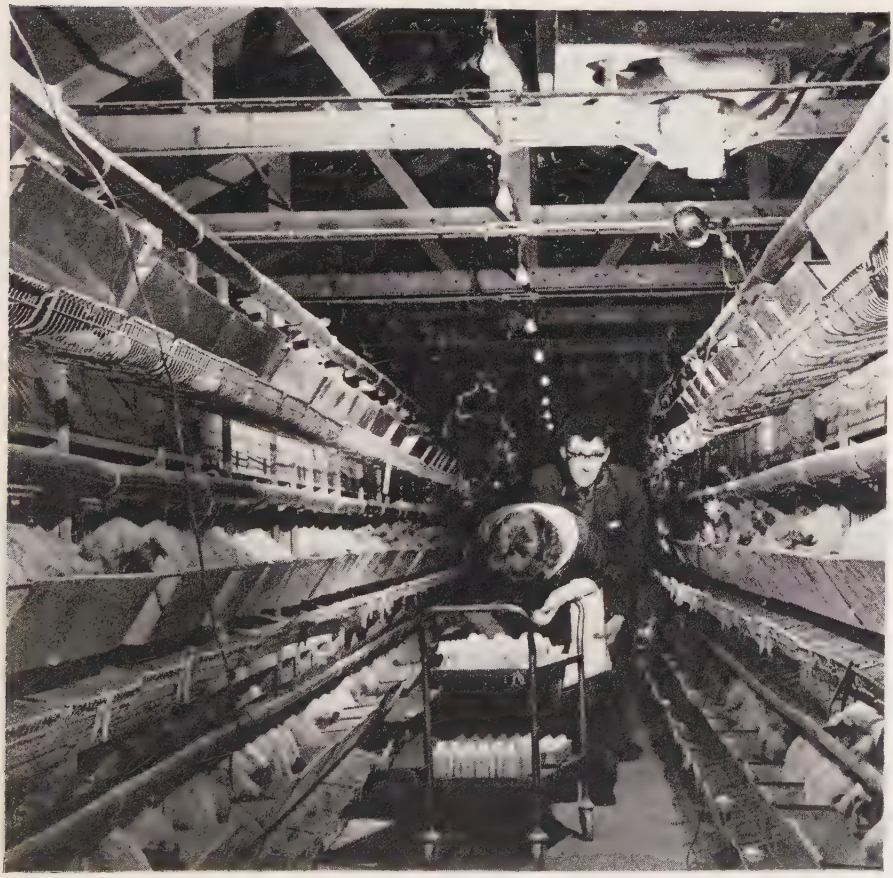
Results from Narrow Rows

For spring barley, reducing the row width has produced a series of positive and negative effects, ranging from a decrease of 2·1 cwt per acre to an

*Holliday, R. (1963), *Field Crop Abstracts* **16**, 2.

†Baldwin, J. H. (1963), *Agriculture* **70**, 1.

Winter wheat irrigation (see page 25).



Recording egg production.

PLATE I

Break crops in systems of intensive cereal growing

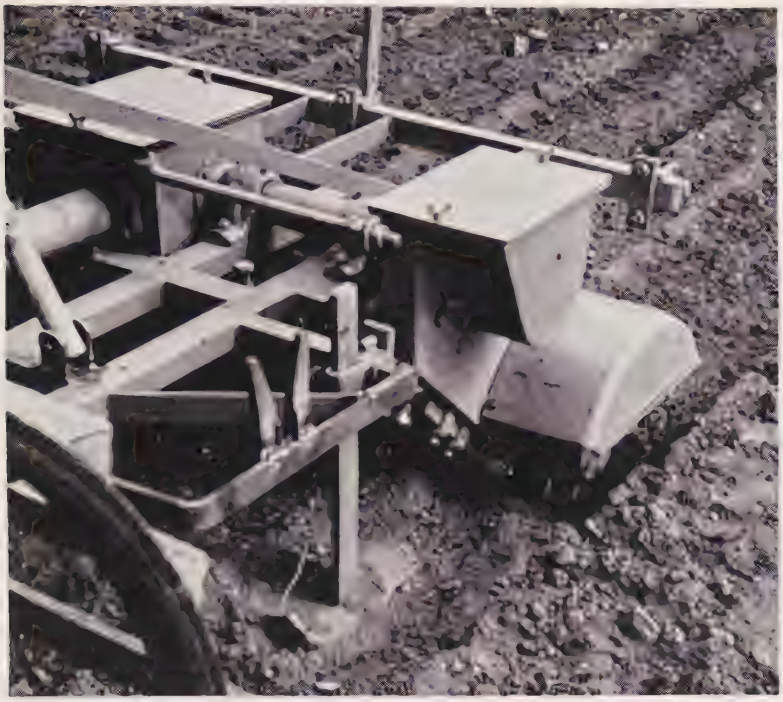
Left hand labelled plot of winter wheat is a sixteenth successive cereal crop. In the centre is a plot of winter beans following fifteen cereal crops. The right hand labelled plot is winter wheat following a similar one year bean break.

Other trials being started on this subject are described on page 60.

Ensiling whole cereal crops

Cutting barley with a self-propelled full-chop forage harvester (see page 61).

PLATE II



New cultivation techniques for potato growing
Inter-row rotary cultivator being used in advance of the planter.

Shallow ridges left by a fully automatic planter following the inter-row rotary cultivator on light silt.

PLATE III

Photo: By kind permission of Associated Photo Services, Liverpool)

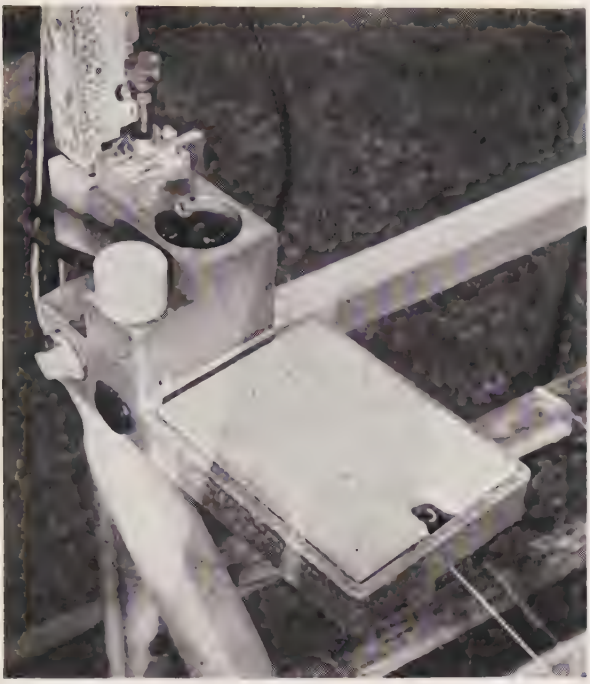
Single suckler cattle

In-calf Welsh Black cows out-wintered on mountain land. Main form of supplementary feed is large concentrate nuggets scattered on the ground.

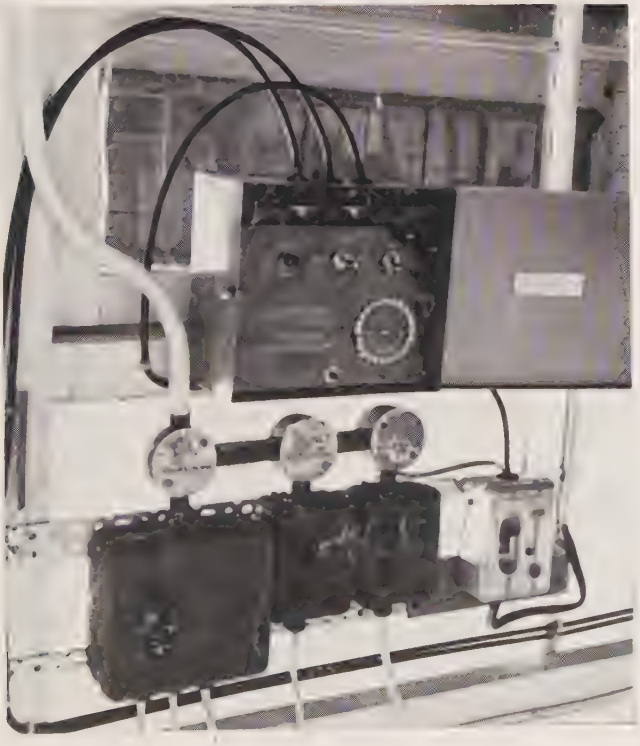
(Photo: Ken Davies)

Welsh Black yearling heifers grazing on mountain land in June after away wintering (see page 63).

PLATE IV



The small evaporimeter



The control unit.

PLATE V

KIRTON EXPERIMENTAL HORTICULTURE STATION

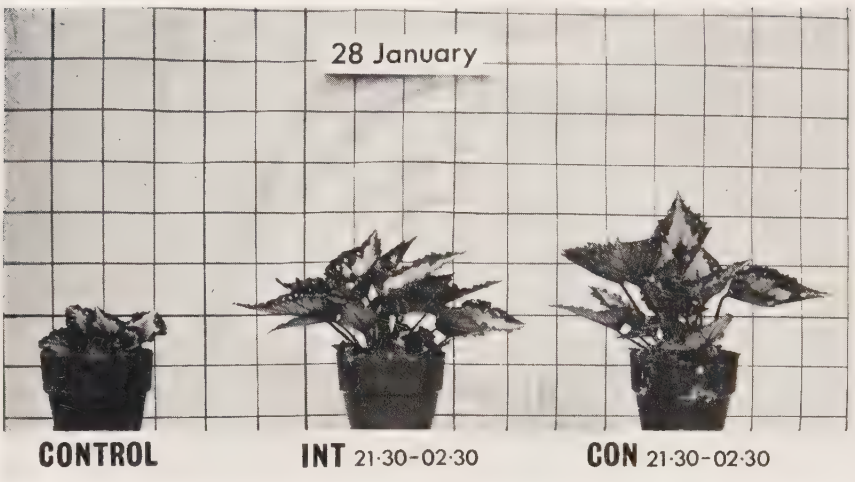
Tulip bulbs treated for direct forcing and grown in water only. Varieties Paul Richter in front, Emmy Peeck behind, planted 12 December, photographed 5 January.

STOCKBRIDGE HOUSE EXPERIMENTAL HORTICULTURE STATION

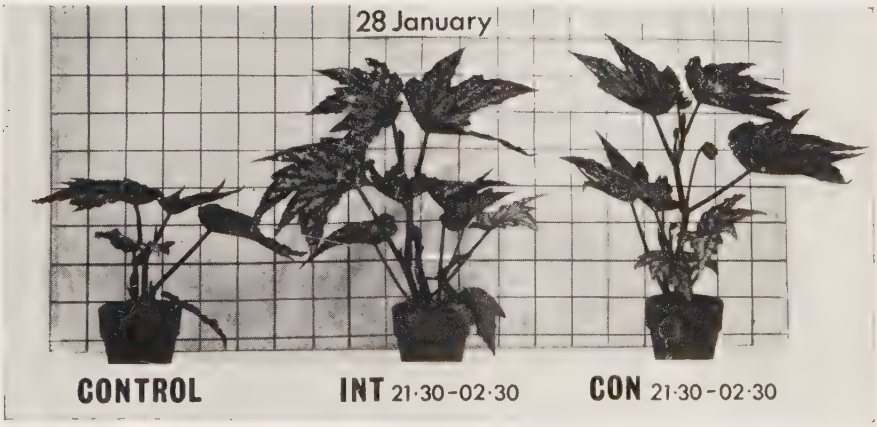
The new glasshouses at Stockbridge House.

Interior of Venlo house.

Interior of wide single span structure—note steep pitch of south facing roof.



Merry Christmas on 28 January after 12½ weeks of treatment: *left* untreated; *centre* intermittent night break; *right* continuous night break.



Filigree on 28 January after 12½ weeks of treatment: *left* untreated; *centre* intermittent night break; *right* continuous night break.

increase of 1·8 cwt per acre. The average over 11 experiments at the three farms is nil. Similarly, with winter barley there is an average increase of only 0·1 cwt per acre. Winter wheat shows a slight decrease of 0·5 cwt per acre from the two experiments where a comparison is possible.

It is conceivable that responses to increased seed rates would be more marked with narrow rows, since within-row crowding would be less for a given plant population. It is only with spring barley and winter wheat that comparisons have been made. With spring barley drilled in normal rows, increasing the seed rate from 84–112 lb per acre produced a worth while increase of 1·5 cwt grain but, beyond this level of seeding, no further increase in yield was obtained. In narrow rows a smaller increase in grain yield (1·1 cwt per acre) was obtained by increasing the seed rate from 84–140 cwt per acre. This is not likely to be an economic increase unless the price ratio of grain: seed is narrower than 1 : 2. These results with spring barley are from six experiments. The seed rate responses of winter wheat were less thoroughly tested (two experiments only) but were very variable. It is not possible to establish whether or not there was a real difference in response between normal and narrow rows. All that can be said is that no case was made for increasing seed rate much beyond 150 lb per acre.

Nitrogen responses of spring barley grown in normal rows have been nearly linear up to 90 units per acre, with an average increase in grain yield of 1·8 cwt for each 25 units N above 40. When grown in narrow rows, the average increase was 1·5 cwt per acre but a greater proportion of the response was obtained by the first increment of nitrogen. Winter barley showed very little difference in the shape of the nitrogen response curves as between normal and narrow rows; the average response was 3·3 cwt grain for each increment of 25 units nitrogen above 40. The results from winter wheat, where the tests were in the 65–115 unit N range, showed negative responses and, therefore, imply that not more than 65 units were justified whatever the drill width.

The general conclusion from the trials comparing normal and narrow rows is that there was no additional grain yield on average for any cereal tested. With spring barley, surprisingly, a rather less efficient use of additional seed drilled and a slightly lower overall response to nitrogen was found. However, medium levels of nitrogen did seem to be more efficiently used.

For winter barley and wheat there is no evidence to suggest a need for a change in nitrogen manuring when narrow rows are used.

Broadcast Crops

Three methods were used; at Drayton and Rosemaund and in one barley trial at High Mowthorpe, seed was 'sprayed' onto a prepared seedbed by releasing the delivery tubes of a coulter drill from the shoes; in the first trial at High Mowthorpe the seed was broadcast by hand but in the later ones a fertilizer drill was used. Care was taken in all cases to ensure that the seed was harrowed in satisfactorily. At Drayton and High Mowthorpe the problem of the 'discard gap' did not arise because it was either not used or made late enough in the growing season to be ignored. For spring barley there was a small (0·3 cwt per acre) increase in grain yield when seed was broadcast but this result (from six trials) is dominated by a very large response in one of the trials. It is at High Mowthorpe that broadcasting the

seed appears to have produced the most consistent results. On average these gave equivalent yields to those from normally drilled cereals. Spring wheat in one trial at Drayton, showed a decrease in yield and the average (but variable) effect with winter wheat has been to return almost equal yields.

Seed rate responses with spring barley have averaged 0·9 cwt per acre for an increase from 112–168 lb per acre. Whilst this is probably uneconomic at first sight, it may be economic if the reduced cost of using a fertilizer drill for seeding is taken into account. From the trials with winter wheat there is nothing to suggest that more seed is necessary, or even desirable, with broadcast crops; small average positive increases beyond 140 lb per acre have been recorded but they are less than the seed required to produce them. Similarly, there is no evidence to suggest a need for a change of nitrogen manuring when spring barley or winter wheat is broadcast rather than drilled.

To sum up, these trials have confirmed that no measurable increases in yield are likely to accrue from the use of narrow coulter drills for cereals. Moreover, if it is convenient to change to the use of one of these drills for other reasons, there is no real evidence to suggest that changes in seed rate or nitrogen manuring are necessary. With broadcast cereal crops it will usually be possible to obtain yields equivalent to those from drilled crops and here, as far as our evidence with spring barley goes it may be opportune, but not imperative, to increase the seed rate by about 15–20 per cent.

RATE OF WILTING FOR SILAGE

D. A. Perks, *Gleadthorpe Experimental Husbandry Farm*

A case for wilted silage was presented in *Progress Report No. 4*, 1963, with data from 1959–62 trials on the labour and crop losses involved in making wilted as opposed to fresh silage. During the three seasons 1963–65, the rates of wilting achieved by various combinations of cutting and swath conditioning machinery were investigated at four Experimental Husbandry Farms. In-field losses and rates of work were also assessed where possible.

The treatments were:

(a) undisturbed mower swath;
(b) mower swath immediately tedded;
(c) mower swath immediately crimped;
(d) undisturbed swath from a flail forage harvester.

All treatments were eventually collected with a forage harvester. Mowers were fitted with an inside as well as an outside swath board where necessary to achieve a clean pick up after wilting.

Bridgets compared all treatments at least twice in each of three years, but obtained no estimates of yield. Drayton, Gleadthorpe and Great House did fewer treatments and replications but yield data were obtained in every case.

The swaths were cut in the second half of May, with three exceptions cut in early June. The investigations were thus made on young herbage at a stage of growth and time of year when high quality silage could be made.

Dry matter determinations were done at all centres at regular intervals on the day of cutting and the following day. Only when rain fell was the wilting period longer than 24 hours and in these cases further dry matter samples were taken as necessary.

Wilting Rate when Rain did not Fall

In trials unaffected by rainfall, herbage cut in the morning averaged 19 per cent dry matter when cut. After 24 hours, undisturbed mower swaths had increased to 28 per cent and tedded swaths to 31 per cent dry matter on average, while in the same time crimped swaths reached 37 per cent and flail-cut swaths 39 per cent dry matter. Herbage cut in the afternoon was usually drier at cutting, being about 23 per cent dry matter on average and, after 24 hours wilting, undisturbed swaths had reached 34 per cent, tedded swaths 37 per cent, crimped swaths 41 per cent and flail-cut swaths 49 per cent dry matter.

Whether cut in the morning or the afternoon, the rate of drying was usually proportional to the severity of the swath treatment, the undisturbed mower swath drying slowest and the flail-cut swath drying fastest. Afternoon cut material also dried slightly more in 24 hours than morning cut material, in addition to having started 5 per cent drier initially.

Tedded or undisturbed swaths of morning cut material were suitable 24 hours later for bunker or vacuum silage. For tower silage, where the minimum dry matter content for the satisfactory working of unloaders seems to be about 35 per cent, crimping or flail-cutting or an extension of the wilting period would have been necessary. Conversely, even undisturbed afternoon cut swaths almost reached the minimum dry matter for tower silage in 24 hours and, although probably suitable also for vacuum silage, afternoon cut material needed ensiling in a bunker silo after less than 24 hours wilting. Material over about 30 per cent dry matter content produces no effluent in a bunker silo but is difficult to consolidate sufficiently to avoid overheating.

Effect of Rainfall

Only two of these experiments were affected by rain. In one case 0·2 in. fell shortly after cutting in the morning and was followed by 0·3 in. over the following two days. After 24 hours the tedded and crimped swaths had absorbed 4 per cent moisture whereas the other two treatments had absorbed only 2 per cent and after 50 hours all treatments were about 3 per cent drier than they had been initially except the flail-cut swaths which were 14 per cent drier than initially. In the other trial 0·3 in. rain fell the morning after cutting, and the flail-cut material, which had been drying faster than the mown material up to that time, absorbed no more moisture than the undisturbed swath and 48 hours after cutting was drying faster again.

Under moderate amounts of rainfall the flail-cut swath did not absorb more water than the mown swath, possibly because it tended to be very compact with a small surface area relative to its weight. It also seemed to dry out satisfactorily after the rain. However, heavy rainfall might have had more serious consequences for the flail-cut swath: evidence from haymaking

trials suggests that a serious loss of soluble carbohydrate occurs if flail-cut swaths are rained on.

Yields

The feature of the yields from these trials was the consistently low weights conserved off plots cut with the forage harvester. This effect was partly due to the longer stubble left by the forage harvester and partly to material not being collected from the swath after wilting because it had fallen below stubble height. The total reduction in yield in these trials, after cutting with the flail forage harvester, was 19 per cent compared with undisturbed mown plots. There was little evidence obtained on the yields from the other treatments but what there was indicated negligible losses.

Machinery Performance

In these trials the mowers cut faster than the forage harvesters because they had a wider swath than most of the forage harvesters and worked at a higher forward speed. Mown swaths were also cleared more quickly after wilting as there were fewer swaths per acre. The overall rate of conserving mower-cut wilted silage was therefore almost as fast as direct cutting fresh silage with the forage harvester, apart from the inevitable day's delay at the beginning of the silage-making programme due to the need to wait for the first area cut to complete its wilt.

Conclusions

Although it gave the fastest drying rate, using the forage harvester for cutting herbage for wilting did result in a reduced yield of forage into the silo, compared with mower-cutting. Part of this difference was due to a longer stubble being left and should be regarded as a total loss if it does not effectively contribute to a subsequent aftermath grazing or conservation cut. The other part of this difference arose when some of the lacerated material cut by the forage harvester was not collected into the trailer after wilting. The proportions of the total loss attributable to these two sources individually are not known. The forage harvester is perfectly satisfactory for collecting mown swaths of suitable width and could be investigated as a conditioning machine for use on mown swaths.

The other system used in the trials of mowing, swath treatment and wilting followed by collection with the forage harvester, worked well and was adaptable to most conditions by varying the time of cutting, the time allowed for wilting or the swath treatment applied. Afternoon cutting gave faster drying than morning cutting when rain did not intervene and it should allow a worthwhile reduction in the time required for wilting. Rain was not a serious complication in the trials and, after moderate rainfall, the treatments dried at the same relative rates as before.

CONCENTRATES FOR COWS GRAZING AT HIGH STOCKING RATES

T. Dixon, *Bridget's Experimental Husbandry Farm*

Summer grazing trials at Bridget's E.H.F. during the period 1956–62 have already demonstrated that supplementary concentrates fed to spring calving cows having unrestricted access to reasonable quality grass, do not raise milk yields profitably but merely increase body weights. No record was kept

of the acreages required for grazing but the cows had access to a grazing and cutting area of between 1·3 and 1·6 acres per cow. It was not possible to detect whether the extra concentrates reduced the amount of grass required by the individual cows or not, because all the cows in each experiment grazed the same grass together.

In 1965 a pilot study was started to find out the effect of concentrate feeding on the acreage required for grazing. In that year two groups of cows grazed separate areas of grass. Both were fed concentrates at flat rates over the grazing season, one group receiving 5 lb per cow per day and the other 11 lb. The cows fed the lower rate were allowed to graze a greater area of grass than the others, as and when they required it. In 1966, a more comprehensive trial was started, using three groups of cows. Two groups were fed concentrates at a flat rate of 2 lb per cow; one of the groups covered 0·66 acres of grazing per cow and the other 0·44. The cows in the third group were fed 6 lb of concentrates per day and covered 0·44 acres per cow. Two thirds of the grazed area was provided by a timothy/meadow fescue/white clover sward in 1965 and in the following year half the area was this type of sward; the remainder in both years was second year Italian ryegrass for early bite and maiden-sown Italian for mid- and late summer grazing. The concentrate, at a cost of £23 per ton, was barley with additional minerals, vitamins and calcined magnesite. In addition to this the cows were offered 2 lb hay per day.

Nitrogen as sulphate of ammonia, at a cost of £14 per ton, was applied to all paddocks at 180 units per acre in 1965. In 1966 the high intensity areas received 420 units per acre while the low area had 40 units per acre less. This was because nitrogen was applied after grazings and there were fewer of these during the season on the low intensity area.

Results for 1965 and 1966

Per cow	1965		1966		
Acreage	0·75	0·50	0·66	0·44	0·44
Concentrates lb	5	11	2	6	2
Milk yield gal	628	636	553	631	573
Total solids per cent	12·41	12·57	12·34	12·30	12·49
Liveweight gain lb	166	115	86	62	31
Per acre					
Milk yield gal	837	1,272	843	1,442	1,309
	£	£	£	£	£
Milk sales	119	182	119	204	186
Concentrate cost	13	42	5	23	8
Nitrogen cost	6	6	14	15	15
Margin	100	134	100	166	163

The large liveweight gain noted in 1965 suggested that further intensification was possible, particularly since it was decided to increase the rate of nitrogen applied in 1966. The results for 1966 confirmed that using 400 units of nitrogen per acre made even higher stocking rates possible. At these stocking rates there was still little benefit from supplementary feeding of concentrates to dairy cows during the summer.

PROGENY TESTING OF PERFORMANCE TESTED RAMS

J. E. Whybrew, *Boxworth Experimental Husbandry Farm*

One of the difficult tasks in sheep breeding is the selection of rams capable of passing on above-average growth rates to their progeny. If it could be established that a ram's own growth rate as a lamb is an indication of the likely performance of lambs sired by him, this would enable breeders to identify the potentially outstanding rams without recourse to the relatively tedious process of progeny testing.

An experiment was started in 1962 at Boxworth and High Mowthorpe Experimental Husbandry Farms to explore this possibility. Each year from 1962 to 1964, sixteen Suffolk ram lambs were produced from breeders' flocks where records were kept. Eight rams were selected from each of two flocks per year; four, whose liveweight gains from birth to at least sixteen weeks were in the upper register of the flock, and four, whose gains were somewhat lower. For convenience the two types of ram were called 'high gain' and 'low gain' respectively. In the autumn of each year two high gain and two low gain rams from each of the two sources were sent to each of the participating E.H.Fs, where they were mated with Scotch Half-bred ewes and the performance of the progeny recorded.

Co-operation between the breeders and the livestock husbandry advisers was close and, as a result, it was possible to devote considerable effort towards ensuring that the ram lambs selected for testing were similar, except in respect of their own inherent growth rates. Each ram lamb was one of a pair of male or male/female twins whose weights were similar. Each year all the ram lambs were born within a reasonably short period and both the high gain and low gain ones were reared in the same group throughout and had the same feeding and management, the aim being to minimize all variation other than the genetic. This standardization meant that the selection field was not as wide as was theoretically ideal. However, there were considerable differences between liveweight gains of the high and low gain rams.

When the rams arrived at the Husbandry Farms, the available ewes were divided into groups of approximately twenty, matched for age as far as possible and allocated to separate paddocks. Each paddock was about 2–3 acres in area and was big enough to supply the needs of each sub-flock during the experimental tupping period. Where fields were sub-divided, precautions in the form of double dividing fences were taken to minimize the risk of rams breaking through to the wrong sub-flock. These precautions were not needed and no trouble was experienced from straying rams.

The rams were turned in to their subflocks at the beginning of October each year, for a period of three weeks for the first two years, but the time was extended to four weeks in the third year. At the end of the period the experimental rams were removed, the sub-flocks were amalgamated and rams of a different breed were introduced to cover any returns to service. During the following winter the in-lamb ewes were managed as one flock in the usual manner. At lambing the number of lambs born, sex, and birth weight of the progeny of each ewe was recorded. Ewes and lambs were

marked so that they could be weighed at within three or four days of eight-weekly intervals (the labour requirement of weighing a few lambs each day on the exact date following each ewe's lambing made a compromise inevitable). After lambing, the ewes and their lambs were turned out to grass and received no supplementary feeding. They were managed on a forward creep grazing system at High Mowthorpe. Weighing continued until all the lambs had reached sixteen weeks of age.

A summary of the results is given in the table.

Daily liveweight gain in lb of rams and progeny (mean of 3 years)

Farm	Ram group and performance		Progeny performance			
	Gain	0–16 weeks	No.	Sex	0–8 weeks	8–16 weeks
Boxworth	High	0·88	135	M	0·59	0·40
			128	F	0·56	0·36
	Low	0·66	130	M	0·58	0·36
			120	F	0·55	0·34
High Mowthorpe	High	0·80	162	M	0·67	0·52
			122	F	0·64	0·49
	Low	0·65	161	M	0·65	0·50
			144	F	0·64	0·47

The summary is, of necessity, brief but it shows clearly that the effect of the ram has been small. The performance of the progeny was divided into two periods to see if maternal influence, which might reasonably be expected to be at its greatest in the early stages, reduced as time passed and the lambs became less dependent on their mothers' milk for their nutrition. The figures suggest that the dams' influence on liveweight performance is certainly greater in the early life of the lamb but that there has been no alteration of the relative position according to whether the sire is a high gain ram or not. Only the figures for twin progeny have been used in the analysis since the number of singles born and reared to sixteen weeks was too small to allow analysis.

There were slightly more singles at Boxworth, 16 per cent, than at High Mowthorpe, 10 per cent, but there is no evidence to suggest that there were differences in fertility between high gain rams or low gain rams. The performance of lambs born at High Mowthorpe has been better than the Boxworth lambs but, once again, the important relative difference between the progeny of high or low gain rams has remained the same.

The results were examined to see if there was any relationship between the weight of the sires at sixteen weeks old and their progeny at the same age. It was not possible to determine whether this factor varied between breeders, since there were different representatives each year. It appeared to vary considerably between the two farms but this difference was far from being statistically significant. Overall, the heritability was about 7 per cent for both sexes; taking into account the inevitable additional random variation between the lambs, the true value could be zero but is unlikely to be greater than 25 per cent.

This result suggests that the heritability of growth rate is not very high and that the use of high gain rams for crossing purposes is not likely to lead to a big improvement in performance of their progeny. It is probably true that there will be a marginal improvement but, for crossbred progeny being sold for slaughter, it will not be of economic significance. In this context it is interesting to note that Bowman and Broadbent,* after undertaking a similar experiment with Down rams of various breeds (with a preponderance of Suffolk rams) being crossed with crossbred ewes, also reported low estimates of heritability for the growth rate of the crossbred progeny. Their estimates ranged from 7–23 per cent, according to the method of pooling and the breed of ewe involved.

The following table of mean live weights, for both sire and progeny groups averaged over the three years of the experiments, may help to emphasize the very small differences which were observed between the progeny of high gain rams and the progeny of low gain rams.

Live weights in lb of sires and progeny at birth, 8 weeks old and 16 weeks old
(Mean of three years)

Farm	Boxworth				High Mowthorpe			
Ram group	High gain		Low gain		High gain		Low gain	
Live weight at:								
Birth	11·2		10·0		11·5		10·6	
8 weeks	58·5		43·5		57·0		42·4	
16 weeks	116·7		86·8		108·9		88·4	
Progeny	Males	Females	Males	Females	Males	Females	Males	Females
Live weight at:								
Birth	12·7	11·5	12·3	11·3	11·2	11·0	11·1	11·0
8 weeks	45·6	43·0	45·0	42·1	49·1	47·8	48·2	48·1
16 weeks	66·5	61·9	65·4	61·3	77·9	76·0	76·3	74·8
No. of lambs	135	128	130	120	162	122	161	144

It is clear that management or geographical and environmental differences between the two farms have contributed more to performance differences than the use of high or low gain sires. It is also obvious that performance testing rams (if all Down breeds are similar in reaction) is going to be of little help to the commercial cross breeder, who is really concerned with the production of fat lambs and is not concerned with the subsequent performance of breeding stock. Even for the pedigree breeder, the use of performance testing is likely to give only a slow improvement in growth rates.

*Bowman, J. C. and Broadbent, J. S. (1966). Genetic parameters of growth between birth and sixteen weeks in Down Cross Sheep. *Anim. Prod.*, **8**, 129–35.

NEMATODIRUS CONTROL ON HEAVILY STOCKED SHEEP PASTURES

E. J. Mundy, *High Mowthorpe Experimental Husbandry Farm*

Stocking pastures intensively with sheep for successive seasons, usually results in severe parasitic worm infestations developing unless effective control methods are used. Young lambs are particularly susceptible to the

nematodirus worm when the worm eggs hatch out in the spring and losses may be very high if no control measures are taken.

Trials at High Mowthorpe over the years 1955–59 confirmed the work of Black and Thomas at Cockle Park and showed that, by resting a contaminated pasture or regular use of an appropriate anthelmintic, an effective measure of control could be achieved. On many farms, however, the resting of pastures from sheep is not practical and anthelmintic treatments offer the only chance of maintaining heavy sheep stocks year after year.

To observe the practicability of three dosing regimes, a trial was started at High Mowthorpe in 1962 and was continued for four years.

Treatments

1. Control: no routine dosing undertaken but appropriate treatment given when sick lambs were seen.
2. Low level treatment every year. Ewes and lambs dosed with methyridine in May at the standard rate and with phenothiazine in late June or July.
3. High level treatment in alternate years
   (a) treated in years 1 and 3
   (b) treated in years 2 and 4
   Ewes were dosed with methyridine in late April when turned on to the pasture and a second and third dose given to ewes and lambs with a three week interval between them. Ewes and lambs were dosed with phenothiazine in late June or July.

Before lambing in late March and early April, all the Cheviot ewes were treated to clear up any worm burden and thereby minimize the spread of worms to the pasture. The ewes and lambs, after lambing in late March and early April, were turned on to the pasture in late April or early May and, with the exception of the first year, were fully maintained on the pasture until early August when the lambs were weaned. The stocking rate was 7 to 7·5 ewes per acre with 11·5 to 13 lambs per acre from 1962 to 1964. In 1965 the stocking rate was reduced to 5·5 ewes and 8·5 lambs per acre, half the area being conserved for silage prior to grazing. In the first three years the sheep were managed on a forward creep grazing system. The ley used was a ryegrass/white clover sward, which received approximately 120 units of N during each grazing season.

Results

The control and low level treatments both broke down in the third and fourth years and additional anthelmintic treatment was necessary to stop scouring and prevent severe loss of condition. The alternate year treatment prevented a high incidence of scour due to Nematodirus infection but a few lambs were affected in the fourth year and were accordingly dosed.

The incidence of scour due to Nematodirus was accentuated in individual lambs because of general outbreaks of coccidiosis in the third and fourth years, thus providing an additional stress factor. The coccidiosis proved to be more serious than the Nematodirus infection but was easier to control by the use of 'sulphadimidine'.

Since a severe outbreak of worm trouble was prevented by the giving of additional dosing on the control and low level treatment, mean individual and group performance was similar under all treatments, such difference as there was favouring the group dosed in the second and fourth years.

Discussion

No one treatment proved fully effective against incidence of Nematodirus infection but the high level dosing in alternate years proved the most effective routine dosing programme. In terms of cost the control treatment, where dosing was carried out only when scouring occurred, was the cheapest and under conditions where the flock can be frequently inspected, this system is satisfactory. This suggests that good shepherding is needed to achieve the maximum benefit from anthelmintic dosing.

OESTRUS CONTROL IN EWES

W. M. R. Evans, *Trawscoed Experimental Husbandry Farm*

Of recent years many attempts have been made to produce a practical method of controlling the breeding cycle in sheep. Early methods used repeated hormone injections or hormone feed additives. These have suffered from high labour requirements and variations in the amounts the ewes have eaten. The most recent development uses a sponge pessary impregnated with a synthetic progestogen.

The technique of this system of oestrus control is the insertion in the vagina of the ewe of a small piece of synthetic sponge which has been impregnated with a synthetic progestogen. A small piece of string is attached to the sponge for easy withdrawal. The sponge, normally known as a tampon, is allowed to remain in the ewe for 16 to 20 days. It is then withdrawn by pulling the string.

Whilst the tampon is in the ewe, the progestogen is slowly absorbed through the vaginal wall. This prevents the ewe ovulating, prevents heat and prepares the reproductive tract for pregnancy and sensitizes the ewe to the female sex hormone oestrogen. On withdrawal of the tampon, the ewe responds rapidly and with great precision, she ovulates and will mate.

At Liscombe and Trawscoed Experimental Husbandry Farms trials with this new technique of oestrus control were carried out in the autumn of 1965, using a type of tampon that is now marketed commercially ('Syncromate').

At Liscombe, 28 Welsh Half-bred ewes were treated, whilst there were a further group of 30 similar ewes forming a control group. At Trawscoed, 39 Beulah Speckled-face ewes were treated and their performance was compared with a group of 55 similar ewes which were not treated.

Tampons were left in the Liscombe ewes for 17–21 days, whilst at Trawscoed the tampons were inserted on 13 September and withdrawn on 29 September. On neither farm was difficulty experienced in inserting the tampons, nor did removal present much difficulty, although at Trawscoed the withdrawal string came away from the tampon in 10 per cent of the ewes. Some difficulty in this respect was also experienced at Liscombe.

During the time the tampons were in the ewes there was no evidence that the ewes wished to mate.

As soon as the tampons had been removed, the ewes at Liscombe were separated into groups of seven with a Dorset Down ram and moved into three-quarter acre paddocks. At Trawscoed the 39 treated ewes ran with 2 Beulah Speckled-face rams in a 15 acre field.

Within a day of removal of tampons about one third of the ewes at Liscombe had been marked by the rams. By the fourth day 86 per cent had been marked. However, 30 per cent of the ewes showed a return to service 15 to 24 days later. At Trawscoed the rate of service was rather similar, 20 per cent of the treated ewes being marked within 12 hours, 75 per cent within 24 hours and all within three days. The rate of breaking first service, at 25 per cent, was also similar.

Due to the high percentage of returns to service, only 46 per cent of the treated ewes lambed as a batch over a one-week period at Liscombe. Ten days later a further 46 per cent lambed. At Trawscoed lambing was more concentrated, 62 per cent of the treated ewes lambing in a seven-day period, followed by 28 per cent three weeks later.

In this particular trial there was sufficient evidence to indicate the possibilities of this technique in oestrus control and subsequent batch lambing. However, if the lambing season is going to be shortened, then it is necessary that this technique must give 100 per cent success, otherwise the need for prolonged shepherding is not going to be reduced. This point is clearly shown in the following table, which gives the spread of lambing in both the group of treated ewes and control ewes at Trawscoed.

	Time of lambing (percentage of ewes)					
	1st 7 days	2nd 7 days	3rd 7 days	2nd period of 21 days	Late	Barren
Treated	61·5	—	—	28·3	5·1	5·1
Control	20	23·7	21·8	23·7	5·4	5·4

At both farms there was no evidence that final lambing percentage, lamb birth weights or lamb vigour, were adversely effected by the technique of oestrus control employed.

LEAST-COST RATIONS FOR PIGS

W. M. R. Evans, *Trawscoed Experimental Husbandry Farm*

With the aim of exploring the technique of using computers to design rations for pigs on a least cost basis, a series of trials was run at Great House and Trawscoed E.H.Fs and at the University College of North Wales, Bangor.

When a computer is used to formulate a least-cost ration, it is always

assumed that the chemical composition of the diet gives a true indication of its nutritional value. Provided adequate amounts of minerals and vitamins are given, there appear to be three major factors that determine nutritional value for pigs. These are the daily intakes of digestible energy and crude protein and the protein quality. Protein quality of most practical pig diets is governed by the lysine content.

As a first step in testing least cost rations, four meals were compounded from commercially available ingredients. They were designed to have approximately 16·4 lb crude protein per 70 lb T.D.N. and 0·88 lb lysine per 70 lb TDN in the meals fed up to 120 lb live weight. A second set of four meals, having 13·4 lb crude protein per 70 lb T.D.N. and 0·6 lb lysine per 70 lb T.D.N. was used between 120 to 200 lb live weight. Several of the meals had unusual proportions of ingredients; their composition is shown in the table below.

The daily T.D.N. allowances were governed by a scale so that, for each treatment, pigs of the same weight received similar daily digestible energy, crude protein and lysine allowances.

Percentage composition and costs of the rations

	Ration I (Control) Barley and weatings	Ration II Maize	Ration III Wheat	Ration IV Maize and weatings
	per cent	per cent	per cent	per cent
Weaner ration				
Cereal	75 (barley)	76 (maize)	85 (wheat)	50 (maize)
Weatings	15			40
Soya bean meal		20		
White fish meal	10	4		
Herring meal			10	10
Meat meal			5	
Cost per ton	£29 15s. 6d.	£31 14s. 3d.	£29 10s. 3d.	£30 16s. 10d.
	per cent	per cent	per cent	per cent
Fattening ration				
Cereal	81 (barley)	84 (maize)	92 (wheat)	65 (maize)
Weatings	15			30
Soya bean meal		16		
White fish meal	4		8	5
Cost per ton	£26 13s. 10d.	£29 0s. 1d.	£27 11s. 5d.	£28 8s. 4d.

At Great House, groups of six Large White pigs were group-fed twice daily in troughs, two pints of water being added to each pound of meal, whilst at Trawscoed, groups of fourteen pigs of the same breed were floor-fed twice daily with dry meal. At both farms water bowls were available. At Bangor the pigs were individually fed.

At Great House, rations II and III were compared in two trials, whereas rations I and IV were fed in one trial only. At Trawscoed the whole trial was repeated twice. The following table shows the growth rates of the pigs from the two Experimental Husbandry Farms.

Daily liveweight gain per pig (lb)

	Ration I (Control) Barley and weatings	Ration II Maize	Ration III Wheat	Ration IV Maize and weatings
Great House				
Replicate 1	—	1·28	1·14	—
Replicate 2	1·32	1·32	1·26	1·25
Trawscoed				
Replicate 1	1·24	1·28	1·29	1·23
Replicate 2	1·29	1·32	1·30	1·24

The differences in performance are quite small, confirming the paramount importance of the three nutritional factors mentioned above. Chemical analyses of the meals used are being carried out to try to explain the small variations that exist between the treatment means. These results are broadly supported by the results obtained at the University College of North Wales, Bangor.

The next table gives the carcass grading of the pigs, from which it can be seen that the feeding of the three unusual rations resulted in carcasses of lower grade than those resulting from feeding the control ration.

Carcass gradings

Carcass Grades	Ration I (Control) Barley and weatings	Ration II Maize	Ration III Wheat	Ration IV Maize and weatings
	per cent	per cent	per cent	per cent
O1	60	41	40	52
O2	30	54	57	44
Others	10	5	3	4

The following table gives the margin in pence over the cost of meal fed to produce one pound of carcass. This composite figure takes into account the efficiency of the meal fed, the killing-out percentage and the carcass grade.

Margin per lb of carcass over cost of meal in pence

	Ration I (Control) Barley and weatings	Ration II Maize	Ration III Wheat	Ration IV Maize and weatings
Great House				
Replicate 1	—	13·98	15·18	—
Replicate 2	15·46	15·21	15·98	14·83
Trawscoed				
Replicate 1	13·17	13·69	15·30	13·23
Replicate 2	12·72	12·36	13·47	11·50

The cost per pound of meal fed was very similar for Rations I and III. (Trawscoed; 2·99*d* and 3·03*d* respectively in Replicate I, 2·94*d* and 3·0*d* in Replicate II) and were least costly. The unusual Ration III, produced by computer, nevertheless left a larger margin per lb carcass than the control ration normally accepted as a suitable ration for bacon production.

This limited trial of unusual rations, which might be produced by a computer, tends to lend strength to the view that, provided adequate constraints are supplied, effective least-cost rations for pig feeding might be computed.

COOLING AND HUMIDIFYING EGGS DURING FARM STORAGE

B. Bastiman, *Great House Experimental Husbandry Farm*

Eggs lose weight during the period between collection and despatch to the packing station. It has been suggested that this weight loss is sufficient to cause a high proportion of eggs to change grade. Weight loss can be reduced by cooling or humidifying eggs during storage and experiments were carried out in July and December at Great House Experimental Husbandry Farm, to assess the economics of installing storage equipment to reduce weight loss and prevent down-grading.

Eggs were either cooled (stored at 50–55°F (10–12·8°C)), humidified (by constantly drawing moist air over them) or kept under uncontrolled conditions in the ante-room of a deep litter cabin. They were stored for one, four or seven days to give a spread over the week representative of commercial conditions with once-weekly despatch to the packers. Batches of thirty eggs were weighed before and after storage, to measure the mean weight loss and samples of twelve eggs per batch were weighed individually to ascertain initial grading and subsequent changes in grade. In all, 4,320 eggs were batch weighed and 864 were individually weighed.

Eggs lost weight on all treatments in both July and December and, in both periods, losses increased significantly with duration of storage. Losses in July were higher than in December as temperatures in July were higher and humidities lower. Even under uncontrolled conditions in July, however, the losses were small. Under conditions favourable to weight loss (i.e., in July) there were significant reductions in weight loss under both cooled and humidified conditions. The losses in the humidifier were significantly lower than those in the cooler. The advantages of cooling or humidifying increased as the duration of storage increased. In December, when ambient conditions were cooler and more humid, artificially cooling or humidifying eggs had no effect on their weight loss.

Weight loss is only of importance if it causes eggs to change grade. The percentages of eggs which fell in grade, based on individual weighings, in each of the two periods were:

Experimental period	Cooled	Humidified	Uncontrolled
July	2·8	1·4	1·4
December	1·4	2·8	0·7

The reasons for the similarity in the general levels of change between July and December, despite the much higher weight losses measured in July, are as follows. The eggs produced in July were from birds nearing the end of the laying season and 73 per cent of these eggs graded large, with an average weight of 67·2 grams, which was more than 5 grams above the limit for large eggs. Consequently there were few borderline eggs which could change grade. The eggs produced in December were from birds which had been in lay for a shorter period. There was a greater spread of egg sizes and more borderline eggs. Few changed grade, however, as weight losses measured in this period were small.

In July, the highest incidence of changes in grade occurred under cooled conditions and yet weight losses were highest under uncontrolled conditions. This was due to the fact that, by chance, there were more borderline eggs in the cooler which would have changed grade under any conditions.

Under Great House conditions, the results indicate that it would be uneconomic to install storage equipment, since the period when there are most borderline eggs coincides with the winter period when losses are minimal. If the losses measured in July are applied to the eggs produced in December, an indication of the maximum saving possible, from the installation of storage equipment, can be obtained. When this is done the result is that cooling or humidifying would prevent two eggs per case of thirty dozen from falling in grade. In terms of financial saving this would give little scope for paying the overhead and running costs of the equipment.

These experiments took no account of the advantages of cooling for improving keeping quality or albumen height as there is no premium paid on such factors as yet.

NIPPLE AND TROUGH DRINKERS FOR CAGED LAYING HENS

P. N. Harvey, *Gleadthorpe Experimental Husbandry Farm*

The use of nipple drinkers for battery cages has increased in recent years, mainly because of the saving in labour in cleaning out water troughs. It is also claimed that less food is wasted because meal tends to accumulate in drinking troughs or is carried away in the exit pipe in the case of a continuous flow system. Although hens quickly learn how to take water from nipple drinkers, it is a reasonable assumption that drinking from troughs comes more easily and naturally to them: there is little evidence to show whether this results in a reduced consumption of water and, if it does, whether egg yield or quality is affected. At Gleadthorpe a comparison between the two types of drinker has been in progress for two years. In the first trial, the experimental birds completed their laying period of 48 weeks in February 1966 and the second group were housed in March 1966 and have completed 32 weeks in lay. At twenty weeks old the experimental light-heavy laying

crosses were housed in 15 × 18in. cages, two birds to a cage. Water was supplied to 240 birds by conventional drip feed troughs and the same number by nipple drinkers located on the outside of each alternate cage division so that one nipple served four birds. Water supply was separately metered to the nipples and the water troughs.

There was a fairly consistent indication that the pullets drinking from troughs laid more eggs than those supplied by nipple drinkers. In the first trial, production from the trough drinker group averaged 248 eggs and from the nipple drinker group 240 eggs, a difference of 3½ per cent. Owing to the limited replication this was not statistically significant but, in the second trial now in progress, the results, after 32 weeks in lay, showed that the trough birds had laid 4½ per cent more eggs than those with nipples.

In the first experiment the birds on trough drinkers laid slightly more large eggs than those on nipples but this trend is not evident this year. In both experiments food consumption was the same on the two treatments. This represents food offered and therefore includes the 1 per cent wastage of food recorded in the waste water from the trough drinkers. There was a large difference in water consumption between the types of drinkers and this difference was quite consistent in the two experiments. Consumption per bird was around 0·42 gal per week from the troughs, half as much again as the 0·27 gal per week drunk by the birds supplied by nipples. Water wastage from the nipples, as recorded in jars on the floor below, was negligible but wastage from the troughs averaged 1¼ gal per bird per week: the volume of wastage, of course, depends on the rate of flow which the drip feed is adjusted to provide but this was maintained, as far as possible, at the minimum to ensure clean water and avoid any stagnation or accumulation of food in the troughs. The fact that the birds drank more water from the troughs was reflected in the wetter droppings found on this treatment. Samples taken in November showed that the moisture content of the droppings from the trough birds was about 76 per cent as compared with 71½ per cent from those drinking from nipples. The extra water drunk by the trough birds was much greater than could be accounted for by any additional water in the eggs laid and suggests either unnecessary consumption by the birds on this treatment or that, owing to the position or insufficient number of water points, the birds on nipples did not drink enough water for their needs. When the present experiment is completed it may be that a clearer picture of the comparison will emerge. The investigation is being carried out in cooperation with local Poultry Advisers of the N.A.A.S.

WATER CONSUMPTION BY BROILER CHICKS

P. N. Harvey, *Gleadthorpe Experimental Husbandry Farm*

It has been reported that the water consumption of broiler chicks rises if the proportion of soya meal in the starter ration is increased. High protein starter rations are commonly formulated with a high proportion of soya meal and chicks fed a ration of this type might, therefore, be expected to

drink more water than normal and some of this would be voided in the droppings. Since broilers are almost always reared on deep litter, this excessive water consumption could give rise to wet litter and difficulties in management.

At Gleadthorpe E.H.F. in 1966, three rations of equivalent energy and fibre content, but differing in protein content, were compared as starter diets for broiler chicks from day old to 28 days. The rations were formulated by substitution of soya meal for barley: the highest protein diet consisted of 20 parts of soya meal mixed with 80 per cent of a commercial broiler starter and the lowest was 20 parts of barley mixed with the commercial starter. The chicks were reared in tier brooders, 600 chicks on each type of ration. Water and food consumptions from 5 to 28 days were recorded and the moisture content of the droppings determined. Since the rations were comparable in energy value and fibre content, it is not surprising that food consumption was roughly the same on all three mashes. Water consumption, however, was consistently higher on the high soya ration; as compared with no soya supplementation, the chicks drank 13 per cent more water in their first fortnight of life and 15 per cent in the second fortnight. On the ration with 10 parts of soya and 10 of barley to 80 of the commercial starter, water consumption was almost exactly half way between the full supplement of soya and none at all. Growth rate was almost the same on the three rations up to four weeks. At three weeks there was a slight indication of wetter droppings on the high soya ration as compared with the other two mashes but, a week later, there was no difference at all in the moisture content of the dung samples. There is no explanation as to what happened to the extra water consumed by the chicks on the high soya ration, as it did not produce higher liveweight gains nor did it appear consistently in the droppings.

Further work may be conducted on the subject.

ANEMONES FROM SEED

A. Elizabeth Jeff, *Rosewarne Experimental Horticulture Station*

Although the bulk of the anemone flower crop in the South West is raised from corms, there are still some growers who sow seed direct. There are some advantages in using seed, in spite of the more laborious cultural methods involved; the grower can perpetuate his own strain and recent surveys have shown that virus is less troublesome than where corms are used.

Seed plots are always included in the experimental programme at Rosewarne. This saves time in assessing the results of the breeding work and also enables new techniques to be studied to overcome the disadvantages which can be listed as follows:

1. the high degree of weed control necessary, particularly in the early stages of the crop;
2. the possibility of crop failure due to dry conditions during germination and immediately afterwards;
3. the early blooms tend to be poor in quality, lacking in substance and stem length. This is particularly true where a quick flowering Dutch strain of seed has been used; the plants will flower too rapidly before making a large enough plant to produce flowers of any substance. Local growers' strains appear to be better adapted as they are later to flower and produce blooms of better quality.

In general, the colour of seed-raised blooms is better than that from corms, winter hardiness is better in many cases and flower quality, later in the season when prices are higher, is as good as that from corms.

The original rate of sowing used at the beginning of the anemone flower growing industry was about 8 lb per acre. This is extremely heavy by present day practice and probably allowed for loss due to drought and weed competition. Three lb per acre is the rate used at Rosewarne and even then plant density may be too high if germination is good.

The woolly nature of the seed makes it impossible to sow in its natural state by mechanical means. Before sowing it is mixed well with slightly damp sand, of not more than $\frac{1}{8}$ in. grist and the whole mixture can then be run through a drill. There is no definite amount of sand for 1 lb of seed, this depends on the grower's particular drill. The small vee belt drill, used for plot work at Rosewarne, delivers 3 lb seed and 2 bushels of sand per acre.

Shallowness of sowing is most important and the best germination will occur where the sand is partly visible after drilling. A depth of more than $\frac{3}{4}$ in. has prevented germination altogether.

The time of sowing is usually during the second half of April. Here again this is different from original practice being later by 2 to 3 weeks. The normal emergence period can be up to 3 weeks, depending on whether the seed is chitted before sowing. After emergence, the seedlings may stay in the cotyledon stage for another 14–21 days before making further growth.

Recent advances in weed control are encouraging. With the advent of paraquat, pre-emergence control has become a simple matter and this, coupled with the use of a good stale seed bed technique, will give a satisfactory initial weed control but this will not give protection for longer than six to eight weeks, depending on the type and density of the weed seed population in the soil. At this stage hand weeding is the only course to take.

The latest trials at Rosewarne investigated the use of activated charcoal mixed with the seed and sand as a protectant against damage from residual herbicides. Charcoal was added to the sand/seed mixture at three rates—1 in 10, 2 in 10 and 3 in 10, all as a volume/volume ratio. This was sown on 12 May after chitting for three days, and simazine at $\frac{3}{4}$ lb active ingredient per acre was applied on 18 May after 0·2 in. rainfall, which left the soil surface in a suitably moist condition. Paraquat at 2 pints per acre was applied to the whole trial, including the control plots, on 26 May. Emergence took place on all plots, even the one treated with simazine which had no charcoal protection but the majority of seedlings subsequently died on this plot, leaving a very thin stand of plants. The amount of protection increased with the concentration of charcoal but even the 1 in 10 rate was infinitely better than no charcoal at all. Hand weeding on the simazine plots amounted to walking through on two occasions to cut out the large weeds which had

survived, whereas the attention required by the control plots amounted to three times as much in terms of man-hours.

This new development has distinct possibilities, particularly for those who are able to irrigate and so overcome drought conditions. The third disadvantage, that of poor strains, can be tackled by the enterprising grower himself. This has been demonstrated by the success achieved by some Cornish growers who have selected their own strains for many years.

LETTUCE VARIETIES SUITABLE FOR AUTUMN CROPS IN HEATED GLASS

J. B. Rothwell, *Fairfield Experimental Horticulture Station*

After the early tomatoes have been removed from glasshouses, an alternative crop is often grown. Many growers sow lettuce seed in mid August and plant in early September, with the intention of cutting the crop in mid November. In order to obtain quick maturity, it is essential that planting should not be delayed beyond the middle of September so that maximum advantage of the autumn sunshine is obtained.

The use of extra carbon dioxide combined with a ventilation temperature of 70°F (23·9°C) also ensures quick maturity. The night thermostat for this crop should be set at 45°F (7·2°C).

Most lettuce varieties do not form hearts in the shortening days of autumn and considerable attention has been paid at Fairfield to finding those that are suitable for this purpose. From extensive trials of possible varieties only three were selected which had many of the desired features. Most of the others formed long narrow leaves with no heart. The three best varieties were Kordaat, Southdown 5B and Cannington Forcing. Kordaat took about 50 days to form a hearted 4½ oz lettuce, was light green in colour and presented a flat back in the market box. Southdown 5B hearted about 5 days earlier than Kordaat but it had the disadvantages of having a pointed base, being rather ragged in the heart and of too dark a colour to be readily selected in a competitive market. Cannington Forcing formed a compact heart in 40 days but tended to suffer from tipburn followed by a wet heart rot.

The Plant Breeding Section of Glasshouse Crops Research Institute has produced two short-day lettuce varieties named Valentine and Neptune. This year, these two varieties were compared with Kordaat and Southdown 5B in a comprehensive trial at Fairfield Experimental Horticulture Station. Both varieties produced excellent material for marketing when grown in a carbon dioxide enriched atmosphere. In the absence of extra carbon dioxide, Neptune exhibited severe tip burn but no such reaction was observed with Valentine.

In 7 weeks from planting, Valentine produced a very solid hearted flat bottomed, 6 oz lettuce when grown in a carbon dioxide enriched atmosphere. The weight of the same variety in non-enriched atmosphere was 4½ oz.

Neptune also produced a lettuce fit for market in 7 weeks from planting out. A 6 oz lettuce was harvested where extra carbon dioxide had been applied but, in spite of a similar weight to Valentine, it appeared to be a larger lettuce on account of its less compact heart. When grown in non-enriched atmosphere the weight was $3\frac{1}{2}$ oz.

These two new varieties, Valentine and Neptune, are very suitable for the autumn lettuce crop. They mature quickly, form an attractive looking lettuce with a much flatter base than Southdown 5B and have the capacity to form a heavy lettuce for the time of year.

Plots of a larger tip burn resistant Cannington Forcing, selected at Fairfield, were grown in carbon dioxide enriched air and were ready to market in 36 days from planting. No tip burn was seen in these plants.

PLUM VARIETIES AND ROOTSTOCKS

J. Ingram, *Luddington Experimental Horticulture Station*

Orchard censuses over the last twenty years have shown a continuing decline in the acreage of plums grown in this country. The acreage in 1947 reached 47,000 but by 1962 this had been halved to 23,767. Despite this trend, some new plantings are being made and for these it is clearly important that variety and rootstock are carefully chosen.

Varieties

The variety Victoria is still the most important, accounting for some 25 per cent of the total acreage but, for the fresh fruit market in particular, there is a demand for both earlier and later ripening varieties.

In a comparison of 22 varieties planted at Luddington E.H.S. in 1952, the highest returns per acre were obtained from the early and late varieties. The ten varieties which gave the highest returns, arranged in descending order were Ontario, Marjorie's Seedling, Laxton's Cropper, Severn Cross, Early Rivers, Czar, Thames Cross, John Innes seedling 3003, Early Laxton and Victoria. Of these the four varieties, Marjorie's Seedling, Early Rivers, Czar and Victoria, are the more useful.

Early Laxton (late July) was the earliest to ripen but has to be picked over to avoid fruit drop. Early Rivers (late July) is a good early variety and made consistently good prices. Stocks of this variety are, however, virus infected and a virus-free clone would enable higher yields to be obtained. The fruit of Ontario (early August) is greenish yellow ripening to golden yellow. It is a heavy cropper and was the most remunerative variety in the trial but the demand for yellow plums is limited. The variety Czar (early August) cropped well and made good prices. Of the midseason varieties only Victoria (mid-August) and John Innes seedling 3003 (early September) showed reasonable returns. Many of the Victoria trees were lost because of bacterial canker

infection. To avoid such tree losses, varieties susceptible to bacterial canker can be high worked using a resistant stem such as Myrobalan B. John Innes seedling 3003 is a heavy cropper but the light yellow fruit is of only moderate quality.

Thames Cross (early September) and Severn Cross (mid-September) both produce large soft yellow fruits which are easily bruised. The heaviest cropping variety in the trial was Laxton's Cropper but market returns were low for this purple culinary plum. Of the late varieties Majorie's Seedling (mid- to late September) was outstanding. It cropped well and prices were high, giving a 75 per cent higher return than Victoria.

Rootstocks

As with apples, increasing labour costs favour smaller trees which can be more easily managed. Incompatibility between scion and rootstock has, in the past, limited the choice of rootstock but suitable compatible stocks of varying vigour are now available. With plums, the vigour of the rootstock has little effect on the age at which the trees come into bearing and even trees on the vigorous rootstock Myrobalan B will crop early in their life.

A trial of seven rootstocks of semi-dwarfing or intermediate vigour was planted at Luddington E.H.S. during the winter of 1952–53. No vigorous rootstocks were included. The rootstocks compared were Pershore, St. Julien K, St. Julien A, ED (33) 4 (a rootstock bred at East Malling), Ackermann's Marunke (a stock of German origin), Marianna and Michaelmas Prune. The two varieties were Early Rivers and Cambridge Gage.

All the rootstocks produced a similar size of tree and, with the variety Early Rivers, the trees reached a height of between 12 and 13 ft by their eleventh year.

The three best stocks have been shown to be Pershore, St. Julien K and St. Julien A, which are all universally compatible with the range of plum varieties. Clean stocks of Pershore rootstock are difficult to obtain but virus-tested clones are being produced.

BOTRYTIS CONTROL IN STRAWBERRIES AT TERRINGTON

R. H. Jarvis, *Terrington Experimental Husbandry Farm*

A trial to investigate methods of controlling *Botrytis cinerea* (grey mould) on strawberries grown for processing was planted at Terrington in November 1964. After deblossoming in 1965, treatments were applied for the first time in 1966. A two-spray programme was used, with applications at 5–10 per cent and 60–70 per cent flowering, each in 200 gal per acre. The sprayer had a boom with nozzles mounted so that three applied spray to each row of plants, one vertically downwards and one from each side.

Botrytis attack was severe in 1966 and both thiram (4 lb per acre a.i. at each application) and dichlofluanid (3 lb per acre a.i. at each application) gave large increases in the yield of marketable fruit. With Cambridge Favourite the increase in yield amounted to some 60 per cent in the case of thiram and 80 per cent with dichlofluanid. Two formulations of thiram were included in the trial, one English and one continental; both gave very similar yields. With dichlofluanid a comparison was made between two spraying pressures, 45 and 100 p.s.i., and yields were virtually the same from both.

Samples of fruit were taken for the estimation of spray residues and for the assessment of flavour after processing. Final conclusions must await the results of these tests, both in 1966 and in subsequent years.

COLUMN STOCKS— SPRING PRODUCTION UNDER GLASS

F. G. Lloyd, *Lee Valley Experimental Horticulture Station*

Stocks (*Matthiola incana*) have been grown for many years as a spring and summer cut flower crop but the introduction of 100 per cent double strains in the Column type has resulted in particular interest being shown in the production of top quality blooms.

Following breeding work in Denmark, it is now possible for growers to produce crops with virtually all double flowered spikes by careful selection of seedlings. The seedlings with normal dark green leaves produce plants bearing mainly single blooms and are discarded, while those with lighter green leaves are retained, as they produce the required double flowers.

The combination of double blooms and long straight stems, which is possible now with the Column strain, gives a cut flower of top quality where cultural conditions are correct.

Research and experimental work on Column stocks has been very limited in Britain but work was initiated at the Lee Valley Experimental Horticulture Station in 1965 on the following cultural aspects which affect the economic production of this crop.

Spacing

Results from 1966 work show that good quality blooms can be obtained at spacings of 6 × 6 in. and 6 × 5 in. for spring crops under glass and, in continuation of this work in 1967, both wider and closer spacings will be included to decide an optimum economic spacing for this period of the year. Adequate space has to be provided for the plants to grow and develop satisfactorily in the poor light conditions of late winter, in order to build up long stems and good flower spikes in the spring.

Nutrition

Opinions vary greatly on the nitrogen requirements for stocks but they are usually grown on the residues of previous crops with little or no fertilizer applied specifically for the stocks, as some growers consider that nitrogen tends to make the plants too leafy and too soft at the expense of bloom size.

At the Lee Valley Station an investigation in 1965, on a late spring crop grown in unheated frames, showed that, on this particular soil, no marked differences could be observed between plants receiving levels of nitrogen varying from $\frac{1}{2}$ oz to $1\frac{1}{2}$ oz hoof and horn per sq. yd.

This preliminary work emphasizes the need to investigate further the interaction of nutrition and spacing for production of this crop at different periods of the year.

Suitable Companion Crops

It is known that F1 hybrid antirrhinums and Column stocks will grow satisfactorily, at similar night temperatures, when planted for spring production under glass and these two crops are being grown in the same environment to compare the economics for market production. The results in 1966 indicated that the gross returns for stocks were similar to those obtained for second grade antirrhinums flowering in late spring.

Establishment of Young Plants

Stocks are susceptible to 'damping off' diseases (*Pythium* sp.), both as seedlings and at the planting out stage, particularly where it has not been possible to sterilize the border soil either by steam or chemicals. Straw beds isolated from the border soil have been used successfully at the Experimental Station for the production of A.Y.R. chrysanthemums and this disease-free medium will be tried for stocks in 1967.

Weed Control

In 1965 promising results were obtained on a small scale at the Lee Valley Station with the application of FW 925 (also known as Tok. E) as an overall spray, about ten days after planting. This herbicide, which has been used successfully on brassica seed beds, does not control chickweed (*Stellaria media*) and, as this weed is a problem on many holdings, a more satisfactory herbicide is required.

WEEDKILLERS FOR OUTDOOR LETTUCE

A. R. Carter, *Luddington Experimental Horticulture Station*

With the advent of space-drilled lettuce crops, the need for effective, sufficiently durable herbicides is urgent. Luddington E.H.S. has carried out weed control trials. No chemical was entirely satisfactory but one or two are worth trying until better materials become available.

Pelleted seed of Trocadero was sown approximately 2 in. apart on 30 March 1966. The following day, plots were treated with 1·0 lb chlorpropham as 2 pints 40 per cent emulsifiable concentrate, 1·8 lb CDEC plus 0·5 lb chlorpropham as 3·5 pints JMS No. 6 and 0·8 lb BIPC plus 1·0 lb PCA as 4·0 lb Alicep wettable powder.

Alicep was an experimental material, as far as lettuce was concerned, and serious damage was caused. Chlorpropham and CDEC plus chlorpropham caused a check to the plants but enough grew away to give a commercially acceptable stand. In the week following the herbicide application, over half an inch of rain fell and this could have washed in the herbicides.

About six weeks after sowing the lettuce, a count of weed seedlings was taken. The herbicides had reduced the number to about one-fifth of the population on untreated plots. The hoeing time was reduced to one-third. The lettuce from the treated plots were a little smaller and a little later.

Direct drilled lettuce: relative hoeing times and yields

Treatment	Weed seedlings per sq. ft on 13 May	Relative hoeing times	No. of heads in grades				Peak harvesting date
			18	24	Waste	Total	
Control—hand hoed	95	100	100	62	8	170	29 June
Chlorpropham 1·0 lb	21	33	56	100	6	162	4 July
CDEC plus chlorpropham	18	33	69	86	8	163	2 July
BiPC plus PCA	15	25	2	18	31	51	4 July

To try to estimate whether or not the grower could accept these disadvantages, calculations were made to see if the reduction in labour costs balanced the reduction in income. They did not, but the use of either of the two herbicides enabled a good commercial crop to be achieved. If rain had not fallen after drilling, the check might not have occurred. If a grower could not hoe the crop before weed competition became too great, a bigger check might have occurred. The herbicides gave reasonable weed control until the lettuce had to be thinned and we would consider the use of such herbicides justified at Luddington if we expected a high weed population.

OPTIMUM DENSITY FOR RUNNER BEANS

P. B. Tatham, *Efford Experimental Horticulture Station*

Many commercial systems of growing runner beans as a stick crop involve very low plant populations and recent experiments at Efford Experimental Horticulture Station have shown that considerable yield increases can be obtained by adopting spacing systems which allow an increase in plant density. These experiments have indicated that the optimum density may well be above two plants per sq. ft, when marketable yields in excess of 30

tons could be expected. This ideal situation would only occur if regular planting, to make full use of the ground, were possible. Grown in rows, as they are, the practical limit for runner beans appears to be about one plant per sq. ft.

In experiments comparing different row and plant spacings, maximum yields were obtained when double rows one foot apart, were separated by a three foot pathway. At this spacing, 6 in. between each seed sown in the row gave the required density of 43,500 plants per acre without restricting individual plant growth: at Efford such a system returned yields of 22 tons in 1965 and over 16 tons in 1966. Closer spacing in the row than this increased inter-plant competition and yields were lower. The importance of keeping inter-plant competition to a minimum was emphasized by the observation that two seeds planted together always gave inferior yields to the single seed. Thus, sowing thicker in the row is not the way to gain increased yields from higher density—more rows are needed. Picking difficulties and other management problems were not increased by the use of narrow pathways.

PEAR SOIL MANAGEMENT

E. Gunn, *Efford Experimental Horticulture Station*

There is still a strong tradition for pear orchards to be cultivated and, although in recent years more orchards have been grassed down, particularly the older ones, there is still a considerable acreage where the soil is cultivated. Very little experimental work has been done on this subject and, with the advent of herbicides, it is possible that there will be a complete change in the concept of soil management for pear orchards. It was therefore decided to lay down a trial at Efford, in the spring of 1966, to compare possible methods. The experimental orchard of 4·3 acres was planted in the spring of 1959; the varieties are Conference, Beurre Hardy and Merton Pride, all on Quince A rootstock, planted 15 × 15 ft.

There are four treatments, two of which compare the traditional methods of sward and cultivations; the third is an overall application of herbicide to keep the land weed-free from March to August and the fourth treatment consists of a 6 ft grass strip down the centre of the alleys to take the passage of tractors and implements, with the remaining area being kept weed free by the use of herbicides. In addition, all the plots are split for two levels of nitrogen. The herbicide treatments are decided from year to year and at present consist of simazine at 2 lb a.i. per acre plus paraquat at 1 lb a.i. per acre, applied in the spring, with spot treatment of any perennial weeds by a hormone weedkiller where necessary.

This is the first large scale experiment of its kind on top fruit in this country. It is hoped that it will provide valuable information, not only on tree performance but also on the long term effects of the treatments on the soil structure.

VIRUS-TESTED GLASSHOUSE CARNATIONS

Derek R. Smith, *Efford Experimental Horticulture Station*

After selecting suitable plants of the perpetual-flowering carnation varieties Ashington Pink, Cocomo Sim, Dusty Sim, Tangerine Sim, White Sim and William Sim, meristem cuttings of five clones of each were cultured by Dr. Hollings and Dr. Stone at the Glasshouse Crops Research Institute. Stock so produced was tested and found to be free from the nine viruses then known to affect carnations. It was passed on to Efford Experimental Horticulture Station for productivity testing—the first time this had been done on any scale—with the object of making material from the best clones available to commercial growers through the Nuclear Stock Association (Ornamentals) in due course.

A mother plant and ten of its progeny from some of the 35 clones were received at Efford on 9 June 1965, and deliveries continued until the autumn. Delivery of a further variety, Saugus Pink, began in mid-September. Very strict hygiene measures were imposed in the propagating house and no visitors were allowed. With generous watering and feeding the plants, some of which were very small on arrival, grew extremely fast. The first harvest of 136 cuttings was gathered and inserted in the mist bench on 29 June. Rooting was generally rapid and, by 15 September, about 1,000 additional plants in the original six varieties had been potted for further cutting production. These had increased to 3,150 by 7 October and growth of the plants was such that about 7,000 cuttings were available for insertion in the propagation bench on 15 December.

The main experiment was planted in a 1/10-acre glasshouse on 11 January 1966, and a subsidiary one, involving the Saugus Pink, followed on 21 February. Spaced at 6 × 6½ in. and at temperatures of 54°F (12·2°C) night, 60°F (15·6°C) day, ventilated at 65°F (18·3°C), the plants were grown as described on pp 14–16, except that hygiene was most stringent and no visitors were permitted through the glasshouse. By this means it was hoped to keep the crop virus-free and, to confirm this, regular sampling visits were made by the G.C.R.I. staff.

Picking began on 6 June. After 12 weeks' cropping the highest and lowest yielding clones of each variety had produced the following, unusually high, numbers of blooms per sq. ft of bed:

Variety	Highest-yielding clone	Lowest-yielding clone
Ashington Pink	33	29
Cocomo Sim	33	29
Dusty Sim	29	28
Tangerine Sim	26	23
White Sim	29	26
William Sim	27	24
Saugus Pink*	27	22

*Planted 6 weeks later.

Blooms are graded for size, quality defects and stem length, and differences between clones of a variety can now be seen. Virus testing has confirmed that the plants were still free from the known viruses at the close of 1966—after almost a year under 'commercial' conditions.

DIRECT FORCING OF TULIPS

Elizabeth D. Turquand, *Kirton Experimental Horticulture Station*

The term 'direct forcing' is applied to tulips when they are kept in cool store for 9 to 12 weeks until forcing is to start and the bulbs are then placed in a rooting medium at a temperature of 55–65°F (12·8–18·3°C) so that growth begins immediately and the bulbs make root and shoot growth simultaneously. In the Netherlands this is known as the 5° method because their bulbs are kept in cool store at 5°C (41°F) until they are to be forced. Cropping of the flowers may be achieved in 4 weeks from planting but may take as long as nine weeks depending on variety, forcing temperature and duration of the cool store period. The optimum temperature and duration of the cool store period are being investigated at Kirton to see whether it is possible to apply 'direct forcing' to the traditional forcing methods of the area. If 5° tulips must be planted in the border and forced at 55°F as recommended by the Dutch, then it would take 8–9 weeks from planting to cropping and the method would only apply to the few growers with mobile glasshouses.

In the first series of trials during 1965–66, two dates, 24 November and 22 December, were selected to start growth in the forcing house. The cool storage period began 12 weeks before these dates, bulbs of seven varieties being kept at 40°F (4·4°C) for the first six weeks, and 50°F (10°C) for the remaining six weeks. The bulbs were then planted in boxes which had been moved into the forcing house two days previously to warm the soil. After boxing, the bulbs were kept in the house which was at 65°F.

Variety Emmy Peeck started flowering four weeks after boxing on 24 November, Paul Richter flowered a week later and Apeldoorn took eight–nine weeks to come to flower, with Rijnsoever, Merry Widow, Bellona and Rose Copland in this order between these two periods. The time from boxing to flowering was about a week less for the later boxing but quality was not so good. When 11–12 cm bulbs and 12–13 cm bulbs of these varieties were grown separately, the smaller bulbs produced many more blind stems; the larger size bulbs are therefore recommended.

Flowering of Paul Richter was quick, quality good and the percentage of blind low. Emmy Peeck flowered first but quality was only fair and there was a high percentage of blind and this also applied to Rijnsoever which flowered a week later than Emmy Peeck. Bellona was the only variety where all the bulbs flowered but flowering was late beginning and stems were short. Merry Widow also flowered with short stems and between 5 and 11 per cent blind bulbs.

Further experiments in the 1966–67 forcing season compared the flowering of bulbs of Emmy Peeck and Paul Richter stored at 40°F for 9, 12 and 16 weeks, with bulbs stored at an initial temperature of 40°F raised to 50°F half-way through the storage period. There appeared to be little to choose between the two treatments for quality, number of marketable flowers and speed of flowering, if the duration of cool storage was the same. The longer the period of cool storage the quicker the flowering but the higher the percentage of blind bulbs.

At the moment, direct forcing, or 5° bulbs, cannot be recommended to growers who wish to force three or four rounds through a forcing house in the winter but experiments are continuing to test results with rooting media such as water, high storage temperatures immediately after bulb lifting and varietal effect. It would solve problems for many growers if soil, boxes and standing ground became a thing of the past.

FLOWER QUALITY IN EARLY FLOWERING CHRYSANTHEMUMS UNDER GLASS

Jean Kinnings, *Fairfield Experimental Horticulture Station*

The cultivation of early flowering chrysanthemums under heated glass has become increasingly popular in recent years: the blooms obtained from plantings made in the borders of the houses between the end of January and mid-March, are marketed from mid-May to late July.

The most useful varieties for this crop are those which flower the earliest as these will catch the good price period in May and June. Prices tend to fall in July, when the protected and outdoor crops begin to appear on the market and when other flowers are in heavy supply.

Many of these valuable first early varieties have a tendency towards excessive neck elongation in the very warm conditions which prevail under glass during the late spring and early summer and this is the main fault which may mar the quality of an otherwise excellent crop.

A trial conducted at Fairfield Experimental Horticulture Station in Lancashire this spring has indicated that an application of B9 growth depressant to the terminal part of the plants, shortly after disbudding the crop, will shorten and strengthen the necks of the flowers, with a marked increase in quality of the bloom produced.

To test the potential of this B9 treatment, a collection of twenty-four early flowering chrysanthemum varieties was grown. The cuttings were struck 23 February and planted out in the glasshouse border on 15 March at a spacing of 8 × 9 in. The plants were pinched three weeks later and the resulting shoots were subsequently reduced to three on each plant. The house thermostat was set to maintain a minimum temperature of 50°F (10°C).

On 23 May, after the crop had been disbudded, B9 was applied as a fine

spray overall, covering the terminal buds and the necks of the plants, i.e., the part of the stem between the bud and the uppermost foliage leaves. The B9 was used at the same strength as that generally used to dwarf 'pot mums', i.e., 8 fl. oz in 1 gal of water. Forty-two plants of each variety were treated, the same number being left untreated for comparison and as a measure of the effectiveness of the treatment.

At harvesting, measurements were made of the length of neck of a sample number of blooms from each plot and the effect of the treatment on plant height was assessed. This was done when each variety was in full pick, which ranged from the end of June to mid-July.

There was a great improvement in the appearance of long necked varieties such as Sunavon which, when treated with B9, produced a neck in better proportion, giving a more balanced bloom: the untreated plants had neck lengths averaging 12½ in., whereas those for treated plants were reduced to 6 in. The overall height of the untreated plants of this variety averaged 48 in. compared with the B9 treated plots which had an average height of 39 in. The stem length of all varieties was quite adequate on the treated plots, in fact the slightly shorter stems were judged to be an added advantage as there was less strain on the support nets.

The B9 treatment not only produced a reduction in length but also strengthened and thickened the neck of the bloom. This was a great advantage in naturally thin-necked varieties, such as Purple Gem and Cricket, where quality was very much improved on the treated plots.

Included in the range of varieties grown in this trial were some naturally short necked, strong stemmed varieties, e.g., Hamburg and Starfire. The B9 treatment did not improve the quality of these varieties and only served to make a short necked variety even shorter producing a squat thick-set appearance which is not attractive.

This underlines the fact that B9 treatment should not be used indiscriminately on every variety grown under glass. Its potential value is for use on varieties which, under these conditions, produce very long or thin necked blooms and there the material promises to be a useful aid in achieving the production of high quality early blooms.

CALCULATED IRRIGATION OF SPRING LETTUCE

Derek R. Smith, *Efford Experimental Horticulture Station*

The establishment of the relationship between the amount of energy entering a glasshouse as sunlight and the loss of water from soil and crop which results, has led to the issue of the N.A.A.S. weekly 'water figure' as a guide for tomato growers. Its use has been widened at Efford E.H.S. to include chrysanthemums and carnations (see pp 14–16) and, with slight modification to account for the amount of ground cover given by the foliage, this has been quite successful.

An attempt was made to add spring lettuce in unheated structures to this list of crops watered by calculation. Four Dutch varieties were sown in mid-October 1965, planted into soil as near to field capacity as practicable and irrigated through overhead spraylines in the following ways:

1. The soil was restored to field capacity ten days after planting.
2. As for 1, plus one inch of water given during the first week of March.
3. As for 1, plus a water requirement calculated from solarimeter records, given monthly, up to a maximum of a half inch per watering.
4. As for 1, plus the calculated irrigation requirement at intervals as it reached one inch of water.

All watering was done regardless of weather conditions.

Between late November and early March, Method 1 required a total of a half inch of water, while Method 4 required five times as much. Each variety grew equally well under all watering regimes, giving yields which exceeded 3,000 crates per acre. The experiment will be repeated in another season when weather conditions should be different but, with present experience, it can be said that there was no disadvantage in calculated watering of lettuce. However, on this occasion, water in excess of a half inch, given ten days after planting, was unnecessary.

DELEAFING OF EARLY BRUSSELS SPROUTS

A. R. Carter, *Luddington Experimental Horticulture Station*

Mechanical stripping of sprouts is simplified by the prior removal of leaves. The earlier this can be done the better, as any stubs of leaf-stalks tend to yellow and drop after a time.

Deleafing trials were carried out at Luddington E.H.S. on the variety Early Halftall which was harvested on three dates.

Seed was sown on 31 January but planting was not achieved until 10 May. This is late for an early sown crop and the yields were not as high as normal.

Effect of defoliation: yields in tons/acre

Defoliation: days before harvest	Harvest dates		
	August 17	August 31	September 14
14	—	0·77	1·49
7	0·53	1·73	1·51
1	1·17	2·53	2·05
Nil—same day	1·19	2·91	1·90

At the earlier harvest dates, the leaves are still required by the plant and drastic reductions in yield are caused by early defoliation. By mid-September, the effects are not so great and this suggests that the deleafing date might not be so important for main and late crops.

Efford E.H.S. is carrying out similar trials on these later crops.

THE NEW GLASS AT STOCKBRIDGE HOUSE E.H.S.

F. G. Smith, *Stockbridge House Experimental Horticulture Station*

It may be claimed, with every justification, that the multifactorial glasshouse unit, now being developed at Stockbridge House E. H. Station, is unique. Glasshouse designs have been compared before but to the best of my knowledge this has never been done on a critical basis. The two designs which are being compared in this case are both constructed with steel and alumimium alloy, one being a Venlo design and the other a wide single span glasshouse, see Plate VII.

In designing this multifactorial unit everything has been done, and is being done, to ensure that the comparison which will be made is one of roof design (roof shape). To this end, both glasshouses are orientated east-west, both use Dutch-light width of glass, although full length Dutch-light glass panes have not been used in the roof of the single-span house because of the difficulty of fixing such large sheets to the long glazing spars so that they don't slip. The houses are identical in width—42 ft—and are the same height to the eaves. Each house is divided into six sections, the sections being approximately 40 ft long. Each section will have individual heating and ventilation control, the control gear being identical throughout.

The four central sections of each house will be used for critical experimental work. The end sections, although identical in size, will be regarded as buffers for these central sections but will also provide the necessary propagation space. The 16 experimental sections will be heated by high speed hot water produced from steam in calorifiers. Of the end sections, those at the western end of each of the glasshouses will be heated by direct low pressure steam and those at the eastern end by a steam to warm air system, in which the air will be distributed through perforated polythene pipes. These end sections will be equipped with staging for propagation purposes. The staging is being designed with a view to providing the maximum staging to pathway ratio and, at the same time, ensuring that the plants on the staging can be handled with the minimum of labour. The heating is being arranged so that a temperature lift of 30°F (16·7°C) can be achieved in the experimental compartments and one of 45°F (25·0°C) can be achieved in the end propagating compartments. As in the immediate future the houses will be used for experimental work with winter lettuce in rotation with tomatoes, following East Riding practice, the 30°F temperature lift in the experimental compartments should be adequate for the time being. It will, however, be possible to increase it at a later stage if the emphasis in our experimental work turns to very early tomatoes or cucumbers.

The roof design of the Venlo house is standard except that the interval between gutter posts has been reduced from 12 ft 6 in. to 10 ft. This is because of the east-west orientation and the need to run tomato rows north-south across the house, the standard planting arrangements being only suited to a module of 10 ft.

It will be seen from the photograph that the roof design of the single-span house is unequal, having a steeper slope to the South than to the North. The object of this design is to get the fullest possible advantage from low angled direct sunshine during the winter and early spring months. At that

time of the year the houses will be cropped with lettuce and the roof design has been adjusted to give the best possible illumination on the floor of the house. In choosing this design the results of experiments, conducted in the uneven-span propagating houses built at Stockbridge House and other E.H. Stations 14 years ago, have been applied.

It would have been interesting to have taken these results a stage further and built Mansard type houses which, it is calculated, would give still better light transmission than the uneven span houses but there are construction problems with houses of the Mansard design.

It is difficult to give a precise comparison of the price of these two different house designs because of the partitions and the extra ventilation control which have gone into building experimental blocks. However, the difference in cost could be in the order of £2,000—£4,000 per acre if built as commercial houses, the single-span houses being the more expensive. It is likely that the cost of the single-span houses could be reduced if, instead of a clear span, growers were prepared to have internal purlin supports as they do in multispan houses. Apart from the advantage of improved light transmission which may be calculated for the single-span houses, this type has only one run of ventilators which should prove an advantage cost-wise where houses are being equipped with automatic ventilation control.

If the extra cost of the single-span houses is to be justified, it must produce a proportionally increased crop return. How is this to be obtained? At the time of the year when differences in light transmission values for single and multi-span houses are likely to be at the maximum, we shall be cropping the houses with lettuce. Our experience is that lettuce crops do not vary much in yield if they are given a chance to reach equivalent stages of maturity.

What increased light can do for lettuce is to improve the rate of growth. We shall hope therefore, to get our benefit from improved light in the single-span houses by maturing lettuce in less time. We shall then only be able to exploit the advantages of improved light fully if we ensure that one crop succeeds another in the lettuce/tomato rotation with the least possible delay.

Past and present work with lettuce and tomato crops on the Station has indicated how a rapid turnover of these crops can be achieved, for example by the use of soil sterilization techniques which do not put the house out of commission for a month or six weeks at a time, also by using container-grown lettuce plants and propagating large tomato plants. Then as each new crop is planted the ground is fairly well covered by a reasonable leaf area of the new crop so that photosynthesis may proceed at an efficient level from the start. We hope also that improved light in our new glasshouses may enable us to use higher temperatures for the growing of lettuce and tomatoes and this again will speed up the rate of cropping. It is our contention that, in modern sophisticated glasshouses involving high capital costs, it is the rate of cropping rather than the total yield of a particular crop to which we must pay prior attention in the future.

New Items of Interest in the Experimental Programme

ANHYDROUS AND AQUEOUS AMMONIA

As part of a N.A.A.S. programme, including experiments on commercial farms, experiments are planned, at several Experimental Husbandry Farms, to compare anhydrous and aqueous ammonia, two liquid nitrogenous fertilizers, with solid forms of nitrogen for cereals and grass. In 1966 there was a trial on barley at Gleadthorpe and observation on the crop at Bridget's, testing anhydrous ammonia, and on grass at Stockbridge House E.H.S., testing aqueous ammonia.

Anhydrous ammonia is a highly concentrated (82 per cent N) liquid nitrogenous fertilizer consisting of ammonia liquefied under high pressure and has only recently become available to farmers in this country. On release of pressure, this material rapidly vaporizes so, when used as a fertilizer, it must be injected below the surface of the soil. Anhydrous ammonia has been used on a large scale in other countries for some years. In general it has been found to be as effective for arable crops as solid forms of nitrogen applied at the same time but some gaseous ammonia has occasionally been lost from very coarse sandy soils or soils with poor tilths. A limited amount of experimental work on grassland has suggested that anhydrous ammonia is inferior to solid nitrogenous fertilizers for grass.

Aqueous ammonia, a less concentrated (24 per cent N) liquid nitrogenous fertilizer, is a solution of ammonia in water under slight pressure. To avoid loss of ammonia this material must also be injected into the soil. The small amount of experimental evidence available suggests that aqueous ammonia is as effective as solid nitrogenous fertilizers, applied at the same time, for arable crops and grass.

Because injection of ammonia into the soil takes considerably more time than top-dressing solids, contractors like to apply ammonia throughout the winter or in the autumn rather than confine operations to the spring. Autumn applications have been quite successful in the U.S.A. and some Northern European countries. Ammonia in the soil is strongly adsorbed and cannot be leached out by rainwater but soil bacteria convert the ammonia to readily leached, nitrate forms. The rate of conversion to nitrate increases with increasing soil temperature, so the risk of loss during the winter is much greater in Britain's mild climate than in the U.S.A. and Northern Europe. Hence experimental evidence is necessary to determine how early ammonia can be applied under British conditions. Evidence to date indicates that November and December injections are not suitable in Southern England and the Midlands.

It has been claimed that, for grassland, a single late winter injection of ammonia at a very high rate can replace periodic top-dressings of nitrogen throughout the season. Experimental evidence is required to test this claim under various soil and climatic conditions.

BREAK CROPS IN SYSTEMS OF INTENSIVE CEREAL GROWING

Experiments on the intensive growing of wheat and barley at a number of Experimental Husbandry Farms have focussed attention on the problems of the build up of disease and weeds. Reductions in yield from the first to the fourth successive cereal crop in 1966 resulted in a mean fall of 17 per cent where winter wheat has been grown at Boxworth, High Mowthorpe and Rosemaund and a mean fall of 25 per cent where spring barley has been grown at Bridgets, Gleadthorpe and Trawscoed. In each case nitrogen was applied to give maximum yield.

The introduction of break crops into a pattern of continuous cereal growing could be expected to improve yields of succeeding crops if it fulfilled one of the following requirements: (i) to provide a complete break from pests and diseases, (ii) to enable adequate control of both grass and broad leaved weeds, or (iii) to maintain or improve soil structure and fertility.

Trials on the possible value of these aspects of break crops in intensive wheat growing systems have recently been started at Drayton, Boxworth and High Mowthorpe. The trials are sited on land which has carried a high proportion of cereal cropping in recent years. Trials of a similar nature are being started in 1967 at Bridget's E.H.F. on break crops for spring wheat and spring barley.

The experiments include a comparison of cereals grown after one and two year breaks with continuous cereal growing. The cropping for the break years is based on:

1. fallow or bastard fallow, to provide a break from pests, weeds and disease;
2. oats, which should give a break as far as disease build-up is concerned;
3. late sown spring cereal, which allows some degree of weed control;
4. beans, to represent a legume break, i.e., a break from pests, disease and, to some extent, weeds; also a possible means of improving fertility.

On the silty clay loam soil of Rosemaund E.H.F., the high incidence of take-all allied with a poor soil structure has markedly reduced the yield of second and third wheat crops. On this farm a trial is to be started to compare various methods of seedbed preparation and sowing for winter wheat and also to assess the value of returning straw or dressing with FYM in an attempt to overcome these difficulties.

Other trials and observations studies on the potentialities of individual crops suitable as break crops are being conducted at a number of farms.

TIME OF SOWING SPRING CEREALS

Traditional sowing dates for spring cereals are now being questioned. On some farms, increases in cereal acreage may result in the drilling season having to be spread over a longer period than in the past, owing to shortages

of staff and machinery. Conversely, on others the introduction of faster sowing techniques, such as plain grain drilling, may allow a given acreage to be covered in a shorter time. On heavy-land farms it may be possible to work down seed beds very early in certain seasons but the desirability of drilling at such times may be suspect, as subsequent wet weather can cause a collapse of the tilth and a loss of plant. Late harvesting of a previous crop, the necessity of allowing weed seeds to germinate or a crop failure, may all make late drilling necessary. Thus there is a need to determine the likely effect of variations from traditional sowing dates on the yield and grain quality of spring cereals.

Experiments were started at Boxworth E.H.F. in 1952 and more recently at the Norfolk Agricultural Station but the range of soil types and climatic conditions remained restricted. Work has now been extended to three other experimental husbandry farms and to commercial farms in two N.A.A.S. regions.

Since nitrogen and varieties may interact with sowing date, these have been included in the experiments. The E.H.F. programme, for the 1966 harvest, included three sowing dates. Spring wheat varieties were sown at Arthur Rickwood and Boxworth; spring barley varieties were sown at Boxworth, Bridgets, High Mowthorpe and the Norfolk Agricultural Station. In all cases the crops were grown on at least two contrasting levels of nitrogen. At High Mowthorpe the scope of the experiment was extended to compare two types of seed bed ('rough' and 'good') and two seed rates. In spite of the difficulties involved in doing an experiment on time of drilling on a commercial farm, the E.H.F. trials are being supported by crop husbandry department trials in two N.A.A.S. regions. In the East Midland Region two varieties of spring wheat and two of spring barley were drilled at two dates at four sites in four counties. In the Eastern Region sites have been found on nine commercial farms to compare two sowing dates.

ENSILING WHOLE CEREAL CROPS

The steady increase in the acreage of barley has inspired a search for new outlets and one of these has been the evolution of diets for cattle consisting of barley straw and grain, together with protein, mineral and vitamin supplements. This prompts the question as to whether it is necessary to separate the grain from the straw if both are to be fed ultimately.

A number of farmers have successfully stored the complete barley crop in tower silos as high dry matter silage, which is very reminiscent of the arable silage of former years. This has immediately raised a large number of questions, such as: the best crop to use and its management, the time and methods of harvesting and the effects of changes in these on the feeding value.

Experiments were started in 1965 at two E.H.Fs. to study storage techniques and feeding quality of whole-crop barley silage. These proved promising and the work has been expanded at four E.H.Fs (Boxworth, Bridgets, Gleadthorpe and High Mowthorpe) to include studies on nitrogen

manuring, times of harvesting, the feasibility of storage in towers, laboratory and animal assessments of feeding value. The main effort is being concentrated upon wheat, barley and oats but the possibilities of other crops may also be explored.

The outstanding advantage of this technique is that the standing crop reaches a stage where its dry matter content is suitable for direct ensiling in tower silos without wilting, thus saving at least one field operation and reducing weather risk, as compared with high dry matter grass silage.

BEEF FROM BRED HEIFERS

The practice of taking a calf from heifers prior to slaughter is not new but has largely lapsed since the withdrawal of the cow-heifer subsidy some years ago.

There is some interest in the revival of this practice as a means of increasing our home produced beef supply. In quick maturing breeds, in particular, there is a tendency for heifers to obtain the necessary degree of finish at light carcass weights. Taking a calf generally leads to greater skeletal development and eventually a carcass of from $\frac{1}{4}$ to more than $\frac{1}{2}$ cwt heavier. In addition, the heifer has left behind a calf of good beef type which, being home-bred, has a big health advantage.

In order to obtain more information on the practice, a trial is being undertaken at High Mowthorpe Experimental Husbandry Farm, where Hereford × Friesian heifers are bulled to calve down at approximately 21 months of age. In the first trial with eleven heifers, satisfactory carcasses were obtained in most instances when the heifers were slaughtered at just over two years of age but the calves were small and the returns, compared with other possible beef enterprises, were not attractive. It suggests the need for further management investigations into level of feeding prior to bulling, age of weaning and the most suitable type of heifer for use in this practice and so the trial is being continued.

SUCKLER HERDS

Price reviews in recent years have emphasized the need for more beef and, although beef from the national dairy herd forms the largest portion of the country's beef output, the expansion of the dairy industry is not likely to provide the additional quantity of beef required. Much of the expansion has, therefore, to come from an extension in suckling systems.

Investigations involving some 200 cows in suckler beef production are being expanded or introduced at a number of Experimental Husbandry Farms.

At High Mowthorpe on the Yorkshire Wolds, as elsewhere on many arable farms, there is a proportion of land which does not lend itself to arable cultivations. Two herds, each of 20 Hereford × Friesian heifers, have been mated to Lincoln Red bulls, the one herd calving in February and the other herd in July. A stocking density of slightly in excess of one cow per acre is proposed but, due to the steepness of the dales, there can be no form of conservation and winter feeding will be based on 'bought in' barley straw with cereal supplements when necessary. The cattle will be housed for part of the winter.

At Liscombe, on the edge of Exmoor, problems associated with the intensification of single suckling will be investigated. When compared with levels used on many dairy farms, beef producers are generally conservative in the use of nitrogen, so the first investigation will examine the possibilities of increasing stocking rates economically by the use of higher rates of nitrogen. The trial will be based on February/March calving and silage from the respective areas will provide the bulk of the winter feed, supplemented, if necessary, with straw and cereals.

Pwllpeiran is in a truly hill farming area where hardiness is an essential factor. Here Welsh Black and Galloway × Welsh Black dams are being compared. Calving normally takes place in March and the steer calves, after weaning in the Autumn, are sent to a lowland farm where their performance is being studied. Heifers are retained at Pwllpeiran and will later be crossed with a recognized beef sire.

A major problem on the hill farm is winter keep and, in an attempt to overcome this, a form of away-wintering is being tried. The policy will be to calve Hereford × Friesians in June and then run them on improved hill land until weaned in early December. The cows will then be transferred to a lowland farm for wintering on arable by-products, returning to the hill farm in early May. The weaned calves would be yarded either at the hill farm or in the lowlands and sold in April, when there is generally a more certain market for them. In this way it is hoped to evolve a system to reduce wintering problems for the hill farmer and enable him to carry a greater head of productive stock. At the same time the lowland partner would avoid the need for capital to purchase cattle for wintering on a traditional basis.

At Trawscoed the collection of input and output data on an inwintered Autumn calving herd and on an outwintered spring calving herd will commence in 1967. Here the Hereford × Friesian dams will be mated with a Hereford sire.

It will be noticed that most of these experiments will be of the 'farm unit' type of exercise. This is largely necessary in order, amongst other things, to obtain reliable records of land use on a whole year basis. In this way a more accurate interpretation of the financial comparisons between systems can be made.

MECHANIZATION OF CAULIFLOWER HARVESTING

At the conclusion of the highly successful single-cut harvesting of Brussels Sprouts by the National Institute of Agricultural Engineering universal vegetable crop harvester at Kirton E.H.S., two experimental models of the

N.I.A.E. machine were tried in a crop of cauliflowers in 1965.This trial demonstrated the feasibility of mechanical harvesting of cauliflowers. A later model of the multi-crop harvester fitted with improved attachments for cauliflower harvesting was used in a further trial at Kirton in 1966.

DIRECT PLANTING AND CROPPING OF BLACK CURRANTS

At Efford Experimental Horticulture Station, black currant cuttings were made and planted immediately from fruiting branches that had been through the picking machine in July, 1964 and compared with cuttings taken at the more usual time in the autumn, 1964 or spring, 1965. The plots were kept clean with simazine. The percentage take varied from 70 on the July cuttings to nearly 100 with the November cuttings, showing that the black currant could be satisfactorily rooted in the summer. The cuttings were planted either one or two foot apart in rows a foot and a half apart. They were not pruned but allowed to crop in 1966. Yield of fruit was highest from the July cuttings and lowest from the March cuttings, those planted in November coming between. Close planting increased all yields. Even allowing for the difference in the percentage take, calculations show that yields per planted acre of $3\frac{1}{2}$–6 tons could be obtained under this system from cuttings rooted in July or autumn. It is suggested that, provided cuttings can be planted economically, close planting of cuttings for machine picking of one crop, the bushes then being rotehoed out, might be preferable to retaining stools with consequent problems of over crowding in the later years. Alleyways would be allowed for spraying with overhead booms. Further work on the treatment of the black currant as a biennial will be carried out to obtain more information on the cultural requirements and the economic aspects of the production of this crop.

WINTER PRODUCTION OF *BEGONIA REX*

The factor which limits the growth of *Begonia rex* during the winter is the length of the night. If the hours of the dark period are reduced, vegetative growth is encouraged. The most economical means of doing this is to use low intensity incandescent light during a part of the night in order to divide it into approximately equal halves. This is already widely done to prevent flower initiation in chrysanthemums, lighting for two to five hours nightly, depending on the number of hours of darkness. With increased intensity, continuous light during the 'night break' may be replaced with intermittent light to obtain the same effect.

Method

A pilot experiment carried out at Efford during the winter of 1965–66 was designed to examine the effect of continuous and intermittent night breaks on the production of *Begonia rex* as a winter pot plant. Leaf cuttings of four

varieties, Silver Queen, Mrs. Hatcher, Filigree and Merry Christmas, were propagated under mist during the late summer and planted into 3½–inch clay pots filled with J.I.P.1 compost. These were spaced at 8 inches square, and the following treatments were begun on 8 November:

1. Natural daylength—the control.
2. Lit from 21·30 to 02·30 hours nightly.
3. As for 2, but the light was intermittent for 25 seconds every five minutes.

The lighting was provided by 60 watt lamps placed 3 ft apart and 3 ft above the bench. Black cotton cloth was placed over the plants in treatments 2 and 3 each night between 16·30 and 08·30 hours to protect the control plants from the effect of the lights. Initially the heating thermostat was set at 65°F (18·3°C) and the ventilating thermostat at 70°F (21·1°C). Both were later lowered by 5°F. From the stage when growth showed a need for it, liquid feeding was done with all routine watering.

Results

Steady growth was made under both the lit treatments, while growth under natural short days was limited, especially during November and December. Plate VIII shows representative plants of varieties Filigree and Merry Christmas on 28 January, and the table gives mean recorded plant heights on 11 February, 13½ weeks after the start of treatment. Flowers were produced on many of the illuminated plants, while none were seen on the controls.

Conclusions

Five hours of continuous light or a total of only 25 minutes of intermittent light each night from early November were sufficient to maintain rapid growth during the winter. Very small, newly-potted plants reached saleable size after seven weeks of treatment, during a time of year when glasshouse shading to prevent leaf scorch is unnecessary.

Results with intermittent light equalled those with continuous light. This was particularly encouraging since this technique not only uses a small total amount of electricity but, if light is used in sequence over a part of the glasshouse area at a time, reduced electrical loading is needed.

Mean plant height (cm) of four varieties of Begonia rex *on 11 February 1966, following three daylength treatments begun on 8 November, 1965*

Variety	Control	Treatment	
		Continuous night break	Intermittent night break
Silver Queen	14	25	25
Mrs. Hatcher	14	32	25
Filigree	14	23	23
Merry Christmas	4	17	20
Mean	12	24	23

Experimental Husbandry Farms and Horticultural Stations

Centre	*Acreage*	*Main Farming and Experimental Activities*
Arthur Rickwood E.H.F. Mepal, Ely, Cambs.	150	Peat soils of varying depth over clay and gravel, studies on wastage under cropping. Arable cash crops, including potatoes, sugar beet, vegetables and cereals: weed and disease control, mechanization.
Boxworth E.H.F. Boxworth, Cambs.	858	Mixed farm on boulder clay. Cereals: intensive cropping, manuring, weed control. Break crops including beans. Feeding and management of Friesians for milk and beef.
Bridget's E.H.F. Martyr Worthy, Winchester, Hants.	1,035	Mixed farm on chalk. Cereals: intensive cropping and manuring. Break crops, including beans and potatoes. Leys, fodder conservation and herbage seed production. Friesian and Ayrshire milking herd: management and feeding studies. Intensive management of Clun and cross-bred sheep.
Drayton E.H.F. Alcester Road, Stratford-upon-Avon, Warwickshire.	450	Mixed farm on Lias clay. Cereals: intensive cropping, also winter beans. Long leys, fodder conservation. Beef cattle: grazing, feeding and calf-rearing. Cross-bred sheep: winter housing of ewes, intensification on pasture.
Gleadthorpe E.H.F. Welbeck Colliery Village Mansfield, Notts.	493	Light sand arable farm. Cereals: intensive cropping, manuring and irrigation. Early and main crop potatoes, sugar beet, carrots and other cash crops: irrigation, weed control and mechanization. Feeding and grazing of Friesian beef cattle. Intensive laying poultry: feeding and management studies.
Great House E.H.F. Helmshore Rossendale, Lancs.	460	High-lying Pennine farm in industrial area. Leys, permanent pastures and rough grazings: experiments on management and manuring. Fodder conservation trials. Rearing and feeding Friesian and Ayrshire dairy cattle. Derbyshire Gritstone Sheep. Feeding and management of Large White pigs.

Centre	*Acreage*	*Main Farming and Experimental Activities*
High Mowthorpe E.H.F. Duggleby Malton, Yorks.	1,080	Mixed farm on high-lying chalk. Cereals: intensive cropping, manuring and husbandry trials. Potato seed growing: seed treatment and weed control experiments. Leys, carrying manuring and fodder conservation trials. Grazing, feeding and calf rearing work with single suckled and artificially reared Friesian and cross-bred beef cattle. Similar work with cross-bred sheep.
Liscombe E.H.F. Dulverton, Somerset	495	Upland grass farm adjoining Exmoor. Manuring and management of grass, fodder conservation. Rearing and feeding. Single-suckled and artificially reared cross-bred beef cattle. Intensive management and husbandry of cross bred sheep.
Pwllpeiran E.H.F. Cwmystwyth Aberystwyth, Cards.	3,100	A mountain farm. Welsh Black and cross-bred suckler cattle: comparison of breeds. Welsh white and speckle face mountain sheep: methods of wintering, feeding, flock management and cross-breeding.
Rosemaund E.H.F. Preston Wynne Hereford	435	Mixed farm on heavy red sandstone soil. Cereals: intensive cropping, manuring. Cider apple variety trials. Variety trials with hops. Grazing and feeding of cross-bred beef cattle and sheep. N.I.A.B. Regional Trial Centre.
Terrington E.H.F. Terrington St. Clement King's Lynn, Norfolk	200	A silt land arable farm. Potato experiments studying varieties, seed treatment, blight and weed control, cultivations, manuring, mechanization etc. Sugar beet, beans, peas and cereals: variety testing and manuring experiments. Feeding work with large white pigs. N.I.A.B. Regional Trial Centre.

Centre	*Acreage*	*Main Farming and Experimental Activities*
Trawscoed E.H.F. Trawscoed Aberystwyth, Cards.	808	A mixed farm on shale soils with moor. Rearing, grazing feeding Friesian dairy cattle, and Hereford, Welsh Black and cross-bred suckler beef cattle: management and feeding studies with Welsh and half-bred sheep. Feeding and management work with large White Pigs. N.I.A.B. Regional Trial Centre.

HORTICULTURE STATIONS

Cleppa Park E.H.S. Newport Monmouthshire	68	Production of soft fruit, vegetable and flower crops under local conditions in the open, and under glass.
Efford E.H.S. Lymington Hampshire	376	Trials with top and soft fruit; vegetables including early potatoes; glasshouse crops including tomatoes, lettuce, flower crops; irrigation.
Fairfield E.H.S. Greenhalgh, Kirkham Preston, Lancs.	22	Glasshouse crops including tomatoes, lettuce; flowers; mushrooms.
Kirton E.H.S. Kirton, Boston Lincolnshire	104	Bulb flower crops including hot water treatment, storage and forcing; strawberries; vegetables especially summer cauliflower.
Lee Valley E.H.S. Ware Road Hoddesdon, Herts.	26	Glasshouse crops including tomatoes, cucumbers, lettuce, chrysanthemums; flowers and some intensive vegetables in the open; mushrooms.
Luddington E.H.S. Stratford-upon-Avon Warwickshire	230	Apples, plums and soft fruit, pest and disease control, nutrition and rootstocks; vegetables; flowers; glasshouse crops; irrigation; weed control.
Rosewarne E.H.S. Camborne, Cornwall	109	Bulb and other flower crops; vegetables, including early potatoes; mobile glasshouses; shelter; weed control.
Ellbridge Sub-station Hatt, Saltash Cornwall	5	The study of crops produced in the Tamar Valley.

Centre	*Acreage*	*Main Farming and Experimental Activities*
Stockbridge House E.H.S. Cawood, Selby, Yorks.	161	Vegetable crops including rhubarb; top and soft fruit; crops and rotations for fixed and mobile structures; shelter; mushrooms; flowers.
National Fruit Trials Brogdale Farm Faversham, Kent	185	Testing and classification of all types of top and soft fruit.

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N·A·A·S EXPERIMENTAL FARMS & STATIONS

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